POST-OCCUPANCY ENERGY ANALYSIS OF THE GWINNETT ENVIRONMENTAL AND HERITAGE CENTER

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Presented to
The Academic Faculty

by

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POST-OCCUPANCY ENERGY ANALYSIS OF THE GWINNETT ENVIRONMENTAL AND HERITAGE CENTER

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To my ever patient wife Priti, and my parents, who would not believe it until they saw it.

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Finally, I would like to thank my wife Priti for patiently supporting and encouraging me through this program, and for forgiving the mountains of laundry and the piles of dishes that were all casualties in the course of this thesis.

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LIST OF SYMBOLS AND ABBREVIATIONS

GEHC	Gwinnett Environmental and Heritage Center
LEED	Leadership in Energy and Environmental Design
USGBC	US Green Building Council
HVAC	Heating, Ventilation and Air-conditioning
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
VT	Visible Transmittance
COP	Coefficient of Performance
EER	Energy Efficiency Ratio
COG	Center of Glass
SHGC	Solar Heat Gain Coefficient
VAV	Variable Air Volume
cfm	Cubic feet per minute
Toa	Temperature of air
TMY	Typical Meteorological Year

SUMMARY

As more and more buildings that were granted recognition for reduced energy use intent, based on predictions from energy simulation models, now acquire a reasonable amount of actual consumption data, it becomes possible to achieve a greater understanding of the efficacy of using building simulation to predict energy consumption.

This study investigates the means to a reduction of energy use in the Gwinnett Environmental and Heritage Center, a LEED [1] Gold Building, using zero-budget, purely operating schedule-based recommendations. Whole Building Energy Simulation was the preferred vehicle of the investigation, with the facility being modeled as-operated in IES-VE Pro Version 6.4 [2] and simulated to achieve a reasonable consumption baseline, and then simulated again after the implementation of recommendations to assess any reduction in consumption, and consequently savings.

Overall energy consumption was reduced by 10%, resulting in an annual savings of $21,160 at a utility rate of $0.08/KWh. This was achieved purely on the basis of reduced artificial lighting, with evidence of natural daylight sufficiency provided by Radiance [3] analysis of a sample space on an hourly, monthly and annual basis.

CHAPTER 1

INTRODUCTION TO THE BUILDING

Figure 1: Gwinnett Environmental and Heritage Center

Overall Description of the Building

The Gwinnett Environmental and Heritage Center is a 59,000 square foot educational facility dedicated to increasing the awareness and appreciation of the natural water resources of Gwinnett County. It functions as both as an educational as well as assembly facility, hosting events varying from wild west camps to weddings. It is also the county's first LEED Gold facility, claiming a reduction of 30% in energy consumption over a baseline case and 75% in potable water use over a comparable facility. In keeping with its heavily wooded surroundings, it also possesses the largest sloped green roof in the southeast, keeping storm water runoff to a minimum. Effective daylighting strategies have also been implemented, with large overhangs and shading devices keeping glare and solar gain to a minimum.

Overview of the Gwinnett Environmental and Heritage Center

A tabulated set of the characteristics of the building are as follows –

- Gross square footage – 59,000 square feet.
- Total Site Area – 233 Acres
- Area of Green Roof – 40,000 square feet, more than 50% at a slope of 4:12
- Total Construction Cost – 16 million USD
- Number of floors – 2
- Owner – Gwinnett County, GA
- Architect – Lord, Aeck and Sargent
- USGBC Certification Level – LEED Gold

Operations and Current Status

The facility has seen a gradual increase in use since it was first opened, and has added functions other than the ones it was initially designed for. It now operates at a very heavy regular schedule of 7:00 AM to 5:00 PM during the working week, with after-hour events like weddings and conventions occurring from 5:00 PM to 11:00 PM on Fridays and over the weekends. This increased occupancy and operations schedule is reflected in the increased energy consumption recorded.

CHAPTER 2

OVERVIEW OF THE PROBLEM

The purpose of this study is the reduction of the energy consumption of the Gwinnett Environmental and Heritage Center, through minimal interventions primarily in operating schedules. The investigations were conducted with the assistance of the firm of Lord Aeck and Sargent and the facilities management team at the Gwinnett Environmental and Heritage Center.

Investigations, Actions and their Scope

The following are the itemized investigations and actions carried out during this study.

List of Investigations and Actions

1. The inspection and summarization of the assumptions of the original energy model (The model that was included in the original USGBC LEED submittal).
2. The collection, from a site visit, of actual occupancy, consumption and operations data.
3. The creation and simulation of a model from the architectural and HVAC drawings to acquire a more accurate energy consumption baseline.
4. The creation of a list of non-invasive (operations only) optimization recommendations.

5. The simulation of the building model with each set of optimization recommendations, to select the combination with the most desirable results.

Scope of Investigations and Actions

1. *The inspection and summarization of the assumptions of the original energy model* – All the assumptions made about the Gwinnett Environmental and Heritage Center in the eQuest energy model submitted as part of the overall LEED submittal are categorized and listed. These assumptions are then compared to the assumptions made in the new IES-VE energy model constructed to achieve a new consumption baseline based on as-built data.
2. *The collection, from a site visit, of actual occupancy, consumption and operations data*. – All available data pertaining to the consumption, occupancy, lighting schedule, operating schedule and any other relevant metrics are collected and categorized. This data is then used in one iteration of the simulation of the newly created IES-VE building model to generate results that can be compared to the actual use data.
3. *The creation and simulation of a model from the design, as-built and HVAC drawings to acquire a more accurate energy consumption baseline.* – The building is modeled in IES-VE from the architectural and HVAC drawings to be as close as possible to building as constructed. This model is then simulated under various operative assumptions.
4. *The creation of a list of non-invasive (operations only) optimization recommendations.* – A list of recommendations that do not involve the addition of any new equipment, fittings or hardware is drawn up. A list

of combinations of these recommendations is then created from the previous list in order to be used in simulation runs of the building energy model. All analysis required to justify the creation of certain recommendations is conducted and results and justification are presented.

5. *The simulation of the building model with each set of optimization recommendations, to select the combination with the most desirable results* – The newly created building model is simulated with –
    - The actual operations, occupancy and other data of the building to create a more reasonable consumption baseline.
    - With different sets of optimization recommendations.

Roadmap of the Study

The study was conducted according to the following timeline –

Table 1 - Study Roadmap

Phase	Description of Work	Deliverables	Start and End Dates	Week
Phase One	Investigation and documentation of model assumptions from original LEED model.	List of assumptions	05/11/2011 – 05/19/2011	1 - 2
Phase Two	On-Site Inspection		05/19/2011	2

Table 1 – Study Roadmap Contd.

Phase	Description of Work	Deliverables	Start and End Dates	Week
Phase Two	Model GEHC in IES-VE from drawings		05/11/2011 – 05/30/2011	1 - 3
Phase Three	Simulation of model with original assumptions	Recording of baseline	05/30/2011 – 06/08/2011	4
Phase Four	Simulation of model with actual use data	Recording of results	06/08/2011 – 06/13/2011	5
Phase Four	Creation of list of optimizations	List of optimizations	06/08/2011 – 06/13/2011	5
Phase Four	Simulation of model with optimizations	Recording of results	06/13/2011 – 06/20/2011	6
Phase Five	Creation of Thesis Report	Thesis Report	06/20/2011 – 06/28/2011	7

CHAPTER 3

A LOOK AT THE PREVIOUS PREDICTIVE MODEL

The original energy model of the building was created in eQuest by Lord Aeck and Sargent for the purposes of achieving a LEED Gold rating. This was done by demonstrating via simulation a 30% reduction in energy consumption over a baseline energy model of the building created in accordance with Chapter 11 of the ASHRAE 90.1- 1999 standard [4].

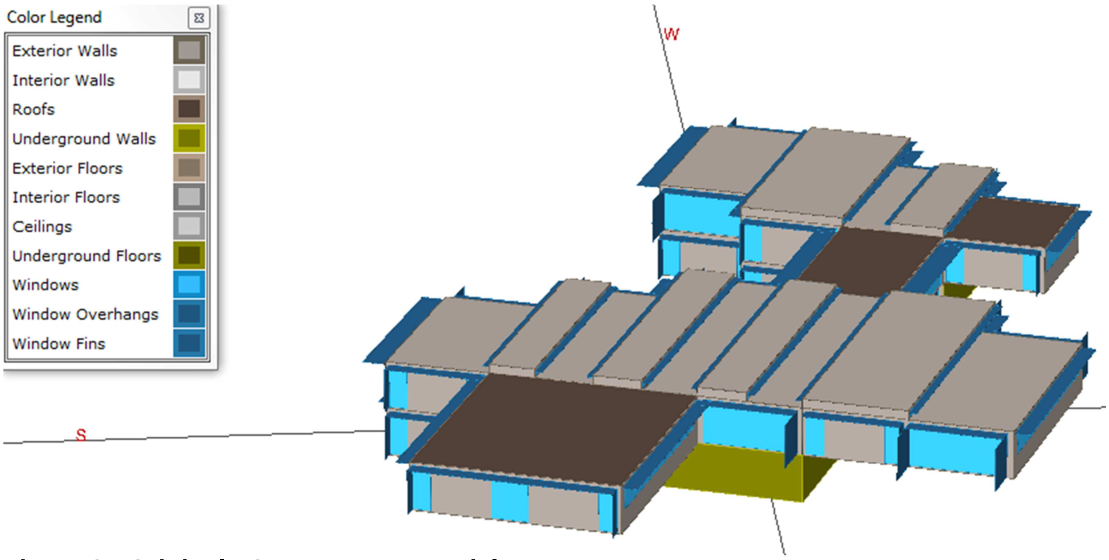


Figure 2 - Original eQuest Energy Model

Overview of the LEED Submittal

The basic improvements made to the building in order to achieve reduced consumption are enumerated below –

Energy Efficiency Measures Incorporated into the Building

1. Increased wall insulation and sod roofs
2. Windows - The original code compliant glazing was 0.35 SHGC, 0.23 VT, and 0.56 BTU/(h °F ft²) U–value (DOE-2 glass code 1470). This was upgraded to AFG ESN glass (0.37 SHGC, 0.455 VT, and 0.306 BTU/(h °F ft²) U-value)
3. External building shades
4. HVAC system upgrade – The screw chillers were upgraded from 4.45 COP to 4.89 (16.72 BTU/W·h EER).
5. Lighting power density is reduced using T8, T5 & Metal halide lamps. Base Case lighting power density averaged 1.6 w/ ft^2, and the design case lighting power density is 1.04 w/ft^2 overall. (This was shown to be less than the actual installed capacity)
6. Daylighting with daylight sensors & controls in all spaces. (These were turned off during actual operation)
7. Occupancy sensors. Occupancy sensors were modeled by reducing the lighting schedule by 15% in each zone.
8. Running plate heat exchangers through a water body designed to reduce load on screw chillers. (This feature was shown to be ineffective during actual operation and was switched off.)

Comparison of Assumptions between the Baseline Building and the Design Case Building (LEED EAC1 [5] Submittal Requirement)

Table 2 - ASHRAE 90.1 LEED EAC Assumptions Comparison

Element	**ASHRAE 90.1-1999 Specification**	**Designed Building**
Floor Area	52,672 s.f	52,672 s.f
Number of Stories	2	2
Average Floor-to-Floor Height	16'	16'
Average Floor-to-Ceiling Height	16'	16'
Window/Glazing Type	**Tinted Glazing**	**Tinted Glazing**
Winter COG Glazing U-Value (BTU/h °F ft²)	0.56	0.306
SHGC	0.35	0.37
Daylight Transmittance	No daylighting	0.455
Frame Type	Aluminum w/o break	Aluminum with break
Shading	No Overhangs	Overhangs (3' to 8')
Window to Wall Ratio	0.385 (11,500 s.f of windows)	0.385 (11,500 s.f of windows)

*Table 2 - ASHRAE 90.1 LEED EAC Assumptions Comparison contd***.**

Element	**ASHRAE 90.1-1999 Specification**	**Designed Building**
Exterior Wall Construction	**Stone masonry**	**Masonry facing with layers**
Insulation (h ℉ ft²/ BTU)	R-5.7 ci	R-18
Total U-Value (BTU/h ℉ ft²)	0.157	0.052
Roof Construction	**Metal framed attic**	**Metal framed sod roof**
Insulation (h ℉ ft²/ BTU)	R-30	R-20 and earth
Total U-Value BTU/(h ℉ ft²)	0.03	0.039
Floor Construction	**6" concrete**	**6" concrete**
Total R-Value (h ℉ ft²/ BTU)	R-6.3 ci	R-6.3 ci
Internal Loads		
Peak Plug Loads (W/s.f)	1.2	1.2
Peak LPD(W/s.f)	1.6 (Average)	1.04 (Average)
Peak Occupancy	80 s.f/per	80 s.f/per

*Table 2 - ASHRAE 90.1 LEED EAC Assumptions Comparison contd***.**

Element	**ASHRAE 90.1-1999 Specification**	**Designed Building**
Mechanical System	**(Cooling)**	**(Cooling)**
Chiller Type	Water-cooled screw chiller	Water-cooled screw chiller with assist from heat exchanged run in water body
Supply Temperature	55F	55F
Cooling Efficiency	4.45 COP	4.89 COP (16.72 BTU/W·h EER)
Mechanical System	**Electric Heating**	**Electric Heating**
Distribution System	VAV	VAV
Supply Fans	High Efficiency Motor	High Efficiency Motor
Supply Fan Total Static Pressure	3” – 3.5”	3” – 3.5”
Minimum Outdoor Air Requirements	15 cfm/per (As per ASHRAE 62.1)	15 cfm/per (As per ASHRAE 62.1)
Thermostat Setpoints	72F / 85F Setback	72F / 85F Setback
Humidity Controls	Yes	Yes
Waterside Economiser	Shutoff Toa>70	Shutoff Toa>70
Hot Water Demand	1 (Gal/per/day)	1(Gal/per/day)

Overview of Modeling Assumptions

A complete list of assumptions made in the original eQuest model can be found in Appendix A. Apart from the general design assumptions elaborated above, certain important modeling assumptions reveal themselves –

1. The sloped roofs were modeled as flat roofs with skylights.
2. The zones were assigned as clusters of rooms of similar occupancy and functionality.
3. Occupancy sensors were modeled as reductions in lighting power density.
4. All conditioned zones were given a setpoint of 70 F.
5. Windows were modeled on a wall-to-window ratio basis, not as designed.
6. Many different daily, weekly and annual schedules were designed to account for differing occupancy, weather conditions, lighting schedules and window dirt.
7. The materials used were different in areas from the actual materials specified in the design documentation.
8. The overall geometry was simplified.
9. Assumptions about electricity and gas prices were made according to the prevailing rates in 2006.
10. A TMY 1 weather file from 2006 was used.

Overview of Parametric Runs

Apart from the as-is run (Baseline), the model was simulated nine times with certain parameters changed during each run. The following are the details of the parametric runs -

1. New Walls and Shades – The overhangs were enabled and the constructions preset *gwin wall* was used.
2. Sod Roof – The roof constructions preset *sod roof* was enabled.
3. Chiller EER – The chiller EER was assumed to be 17 for this run.
4. Daylight On – The daylighting sensors were enabled for all zones.
5. AFg Glass – The glass type AFG Gwinnett GT was enabled.
6. Spacer – The frame spacer type was changed to insulated and the frame was given a conductance of 0.3 Btu/h-ft^2-°F
7. LPD – The Display, Mech, Classroom and Office zones were given a Lighting Power Density value of 1.03 w/ft^2
8. Occupancy Sensors – The occupancy sensors were modeled as a 15% reduction in the lighting schedule.
9. Humctrlrun – The humidity control parameter was set to a value of 60.

Results of Parametric Runs

Table 3 - Results of the Parametric Runs

Profile	Annual Energy Consumption KWh
Baseline	1222270
New Walls and Shades	1204000
Sod roof	1188400
Chiller EER	1006600
Daylight On	930760
Afg Glass	871190
Spacer	864200
LPD	838950
HumCtrlRun	1225600
Occupancy Sensors	820550

CHAPTER 4

A DISCUSSION OF THE RESULTS OF THE PREVIOUS MODEL

Comparison of the Results of the Parametric Runs

Detailed results of the simulation of the parametric runs are available in Appendix B. The comparison of the results of simulating the parametric runs is shown in the graph below –

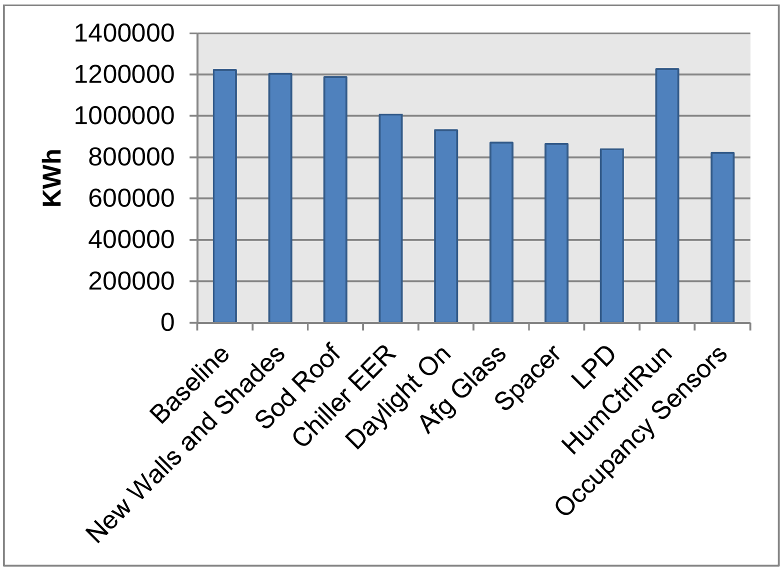


Figure 3 - Comparison of Results from Parametric Runs

Inferences from Comparing the Results of the Parametric Runs

1. Controlling humidity is most energy intensive, therefore the consumption during the humidity control run is almost the same as the baseline consumption. Due to the size of this facility and the differing occupancy in its zones, there is almost always simultaneous humidification and dehumidification. Also, since the humidity is set at 50% even in winter, the air is dehumidified by cooling it down to the

inlet temperature of 55F, and then heated back up at each individual zone.

2. The addition of shading seems to have little effect on the energy consumption of this building. As we experience greater reductions in energy use from changing the glazing type, this implies that direct solar heat gain is not a major source of the cooling load in this building.

3. Changing the R-Value of the roof has a mild impact on consumption, indicating that heat gain through the roof is not as big an issue as other heat gains.

4. Changing the EER of the chillers to 17 BTU/W·h (which is higher than their actual specified value of 16.72 BTU/W·h) has a moderate effect on the energy consumption. This is because space cooling is the largest consumer of energy in the facility, as shown in Appendix 2.

5. The LPD (Lighting Power Density) and glazing runs show the greatest reductions in consumption. This implies both a reduction in cooling loads and plug loads, both of which are very high in this building. Lighting is the third largest consumer of energy in the facility, after cooling and heating as the results shown in Appendix 2 show us.

<u>Note on Potential Interventions</u>

In a standalone comparison of the results of the parametric runs, the heaviest reductions in energy use come from lowering the lighting power density (Daylighting, LPD and Occupancy Sensor runs) and changing the glazing type. No other parameters seem to produce results close to the reduction shown by these. This indicates that any intervention that aims to produce the greatest reduction in energy consumption must come from reducing the lighting power density, as the glazing is already installed and will be difficult and expensive to replace. Lighting Power Density seems to be the area where the highest returns on investment may be expected.

Actual Consumption Data of the GEHC

Annual energy consumption data was available from the GEHC for the years from 2007 to 2011, showing a monthly breakdown of energy and monetary cost. A comparison of monthly consumption is shown in the graph below. For details of the actual energy consumption of the GEHC, see Appendix C.

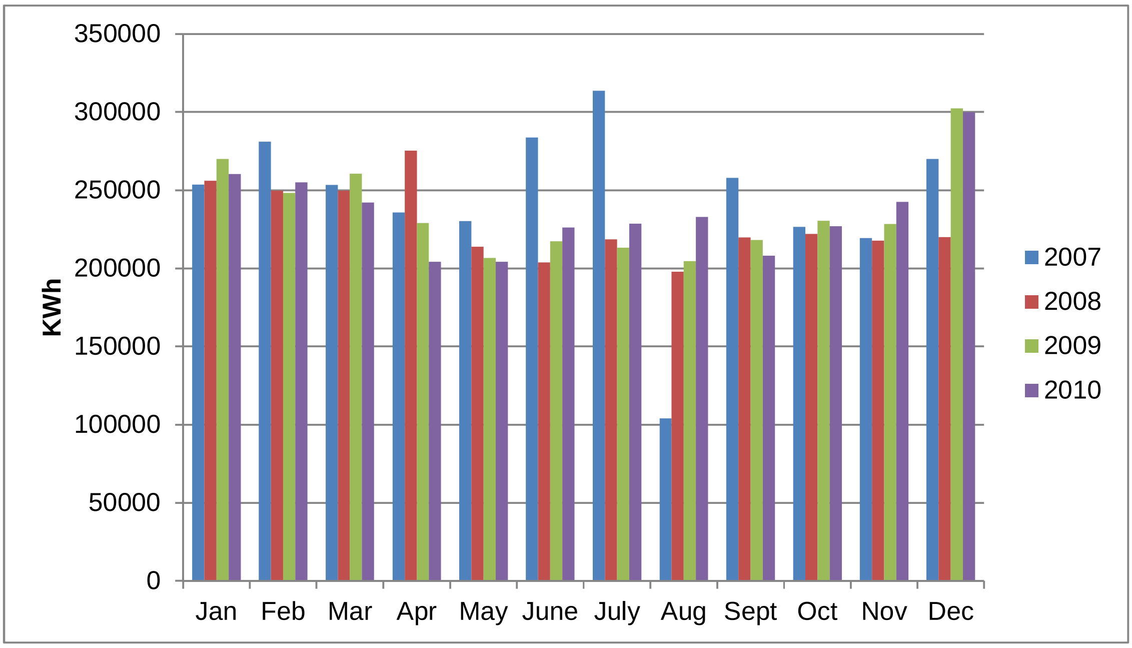


Figure 4 - Comparison of Actual Monthly Energy Consumption

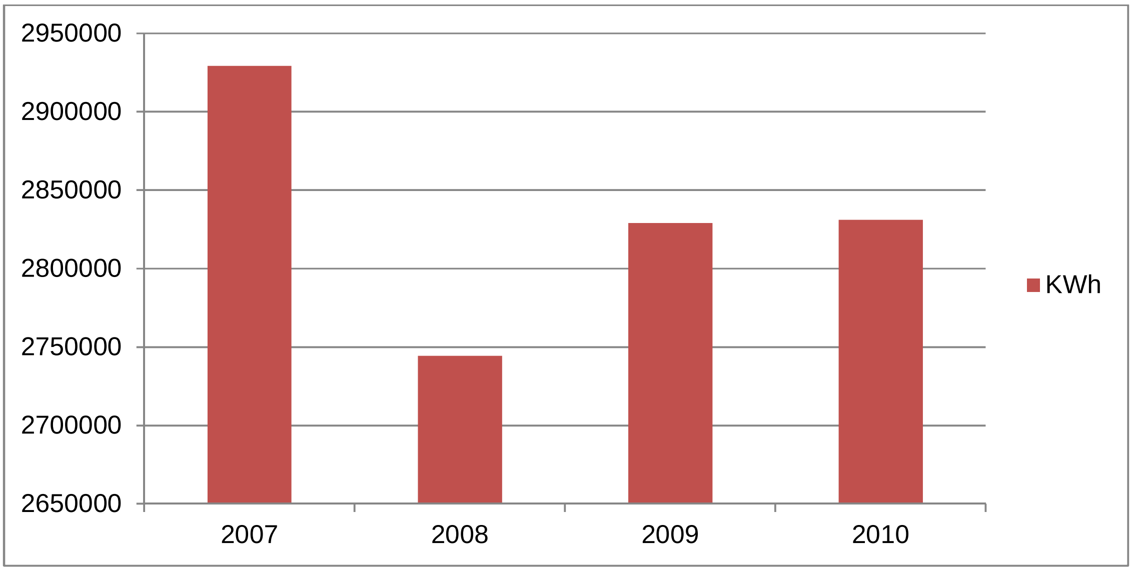


Figure 5 - Comparison of Actual Annual Energy Consumption

Inferences from the Actual Consumption Data of the GEHC

1. The facility shows inordinately high energy consumption during its first year of operation (2007), but seems to have recalibrated its operations to reduce consumption significantly from the next year (2008).

2. The highest consumption occurs during heating season, which can be attributed to the fact that all the heating is electric. This electric heating occurs after either a humidification or dehumidification cycle, further increasing the energy consumed. All evidence points to simultaneous heating and cooling even during heating season.

3. The increased consumption across the board in 2010 can be attributed to the fact that 2010 and 2011 till date have been much busier years for the facility than previous years, in terms of both longer operation and greater occupancy.

Comparison of Actual Consumption Data with the Data from the Parametric Runs

The predicted annual consumption of each parametric run was compared to the annual consumption data for each year. This was done to see how close the predicted values across parametric runs were to the actual usage value. As the facility is not operated as predicted, there was no expectation that the results of simulation would be proximate to the actual usage. The absence of sub metering also denies us the ability to itemize the consumption by component, which would have been invaluable. A detailed comparison in available in Appendix 3.

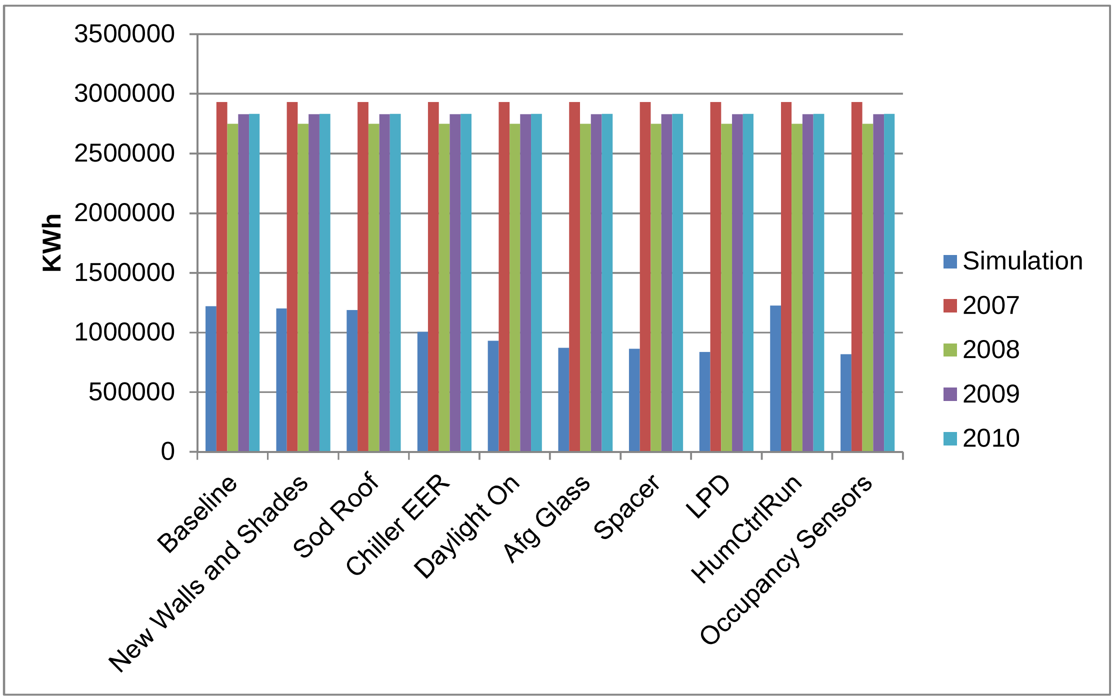


Figure 6 - Comparison of the Results of the Parametric Runs with the Actual Consumption Data

Inferences from Comparing the Results of the Parametric Runs with the Actual Consumption Data

1. The predicted consumption is consistently within 29% to 45% of the actual consumption. This calls into question the efficacy of either the modeling assumptions or the modeling software. As we shall see later in Chapter 8, modeling assumptions have a far lesser impact than the actual 'black box' modeling engine in the software package.

2. Detailed building simulation is a not necessarily a good predictor of actual building performance.

3. Assumptions made to accommodate ASHRAE 90.1 1999 Chapter 11 [4] while modeling tend to substantially affect the results of simulation, as the simulation is performed to satisfy the requirements of a rating system and not necessarily to predict actual performance.

CHAPTER 5

CREATION OF THE NEW MODEL

The new energy model was created in the software package IES-VE Pro version 6.4. The original design documents, EAC submittal and data collected during the site visit were used to model the facility. All assumptions made are from the design documents or the LEED EAC submittal unless specified that the assumptions under question have been made from actual data.

Creating the Geometric Model

The building geometry was first modeled in Google Sketchup Pro 8 [6] from the original design documents, and then exported to IES-VE Pro through the IES-VE toolbar for Sketchup.

Figure 7 - Procedure for Modeling Geometry

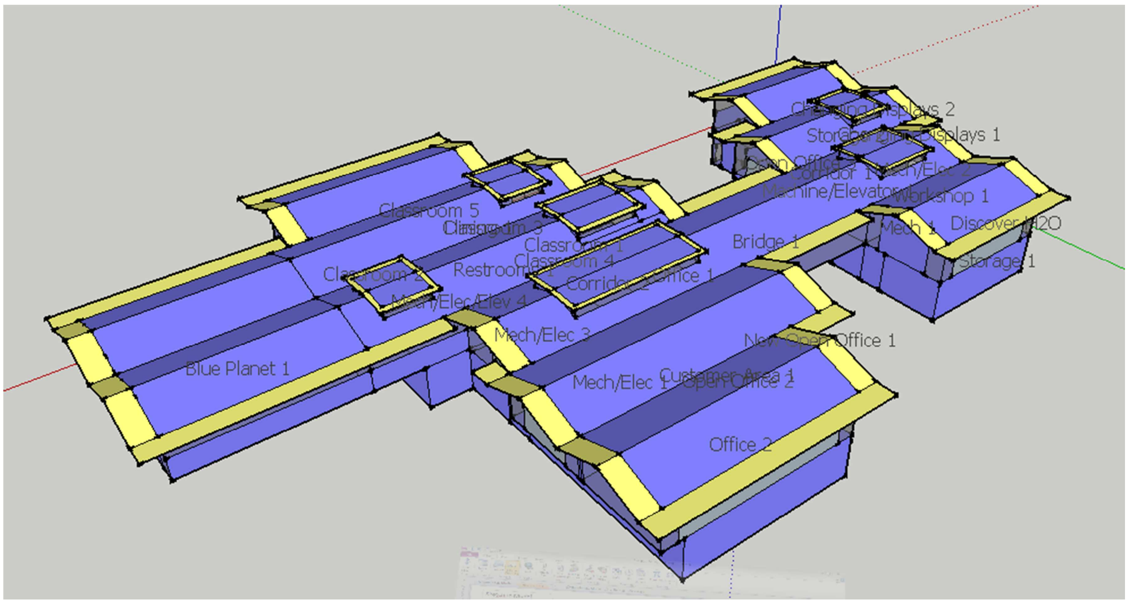


Figure 8 - Original Sketchup Model

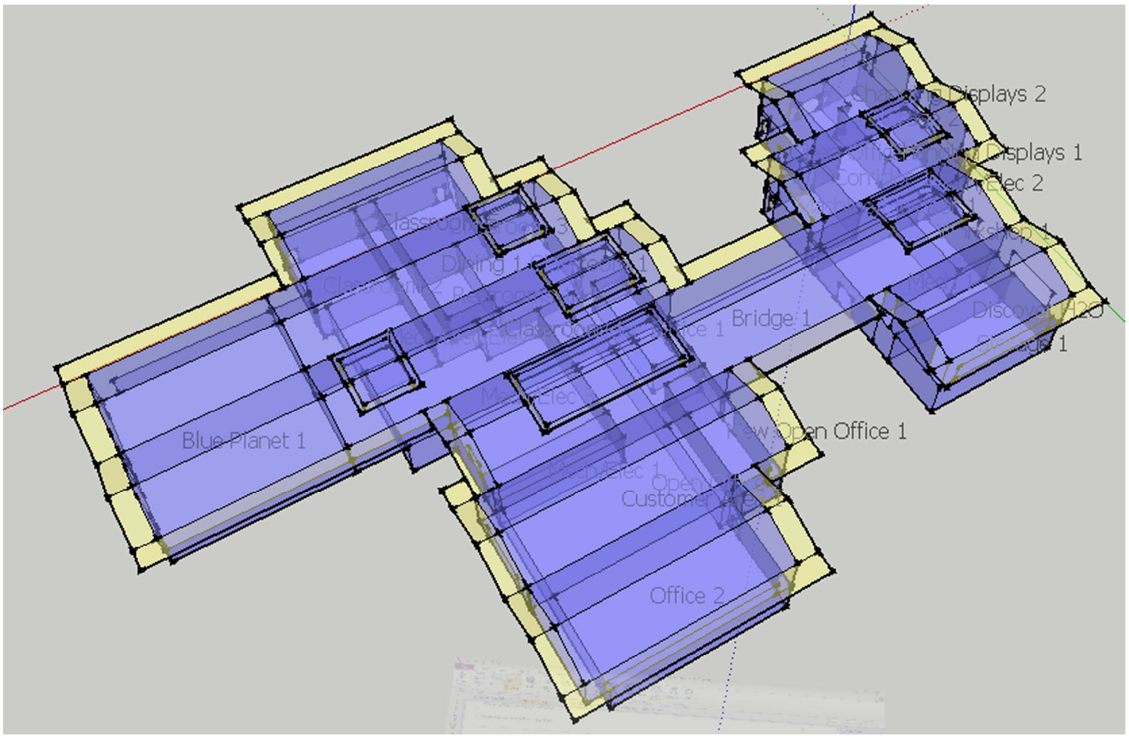


Figure 9 - Sketchup Model showing Internal Zones

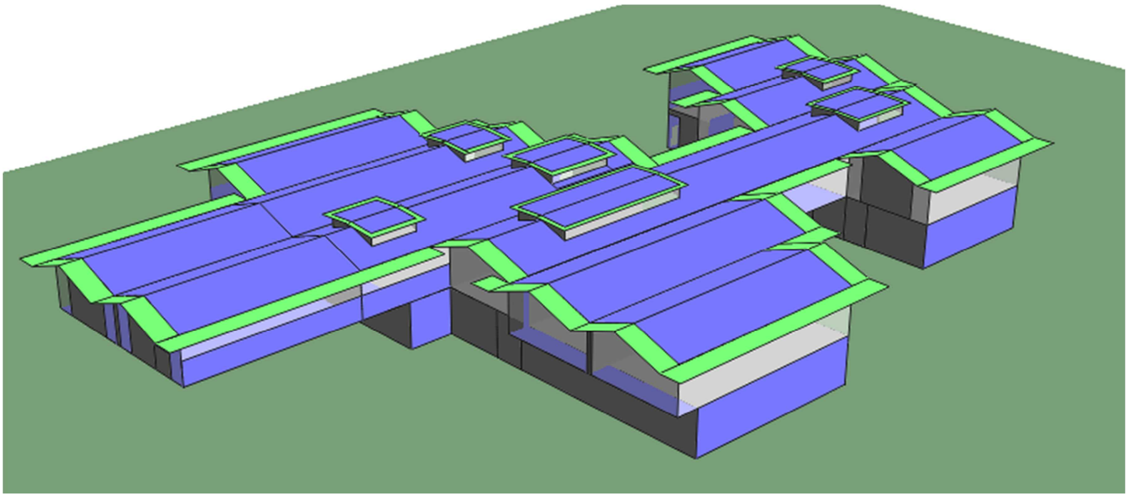


Figure 10 - IES-VE Model

Assumptions made in the IES-VE Model

The modeling assumptions made in IES-VE have been categorized as follows –

1. Assumptions about Geometry
2. Assumptions about Materials and Construction
3. Assumptions about Thermal Conditions
4. Assumptions about the HVAC System
5. Assumptions about Zone Internal Gains
6. Assumptions about Infiltration
7. Assumptions about Artificial Lighting

Assumptions about Geometry

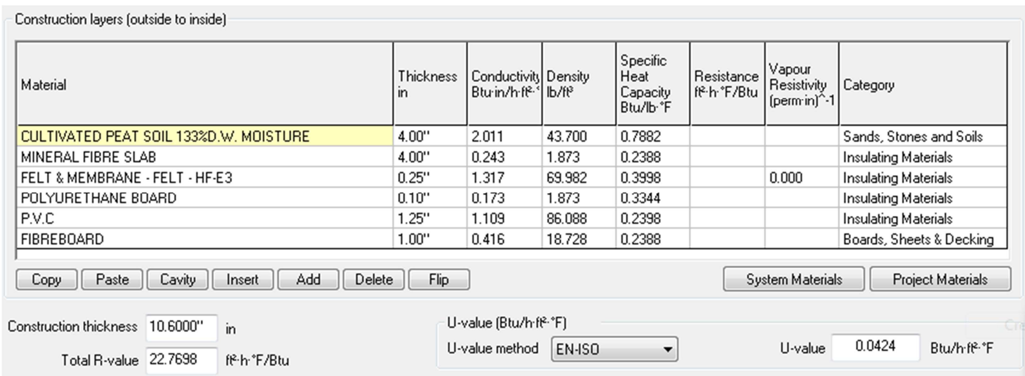
The geometry of the facility was modeled as close to the actual geometry as possible, with the only change being –

1. All shading devices apart from the overhangs have been removed. This was done because the shading devices had minimal impact on the energy consumption of the facility, as shown from the analysis of the previous model.

Assumptions about Materials and Construction

The assumptions made in the model about materials and construction have been categorized as follows –

1. Green Roof – The roof was modeled as constructed with all the different layers of materials and their U-Values. The overall R-Value of the roof is R-22 h ℉ ft^2/ BTU, which is close to the assumptio n made in the previous eQuest energy model, which was R-20 h ℉ ft^2/ BTU.

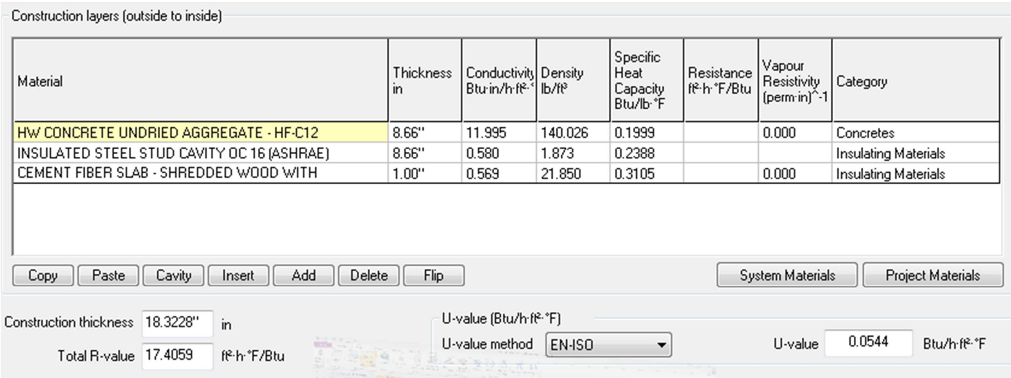


Construction layers (outside to inside)

Material	Thickness in	Conductivity Btu·in/h·ft²·°F	Density lb/ft³	Specific Heat Capacity Btu/lb·°F	Resistance ft²·h·°F/Btu	Vapour Resistivity (perm·in)^-1	Category
CULTIVATED PEAT SOIL 133%D.W. MOISTURE	4.00"	2.011	43.700	0.7882			Sands, Stones and Soils
MINERAL FIBRE SLAB	4.00"	0.243	1.873	0.2388			Insulating Materials
FELT & MEMBRANE - FELT - HF-E3	0.25"	1.317	69.982	0.3998		0.000	Insulating Materials
POLYURETHANE BOARD	0.10"	0.173	1.873	0.3344			Insulating Materials
P.V.C	1.25"	1.109	86.088	0.2398			Insulating Materials
FIBREBOARD	1.00"	0.416	18.728	0.2388			Boards, Sheets & Decking

Figure 11 - Roof Construction and Material Details

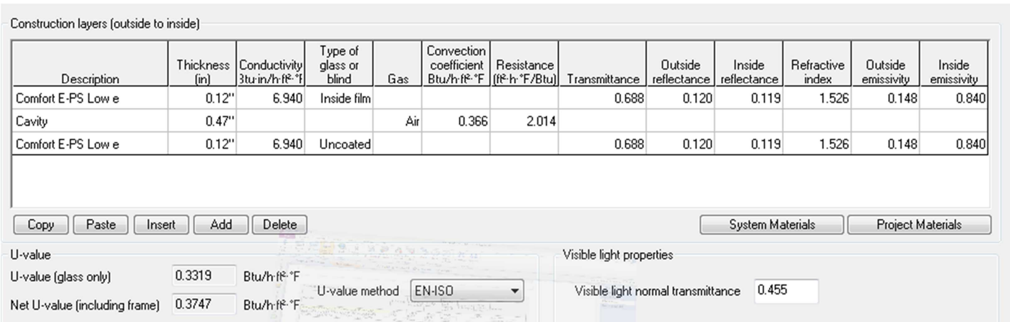
2. External walls – The profile GEHC 1’4” WALL was created to match the approximate U-Value of the differing wall constructions, with a total U-Value of 0.0544 BTU/h ℉ ft ^{2}.


Construction layers (outside to inside)

Material	Thickness in	Conductivity Btu·in/h·ft²·°	Density lb/ft³	Specific Heat Capacity Btu/lb·°F	Resistance ft²·h·°F/Btu	Vapour Resistivity (perm·in)^-1	Category
HW CONCRETE UNDRIED AGGREGATE - HF-C12	8.66"	11.995	140.026	0.1999		0.000	Concretes
INSULATED STEEL STUD CAVITY OC 16 (ASHRAE)	8.66"	0.580	1.873	0.2388			Insulating Materials
CEMENT FIBER SLAB - SHREDDED WOOD WITH	1.00"	0.569	21.850	0.3105		0.000	Insulating Materials

Figure 12 - External Wall Assumptions

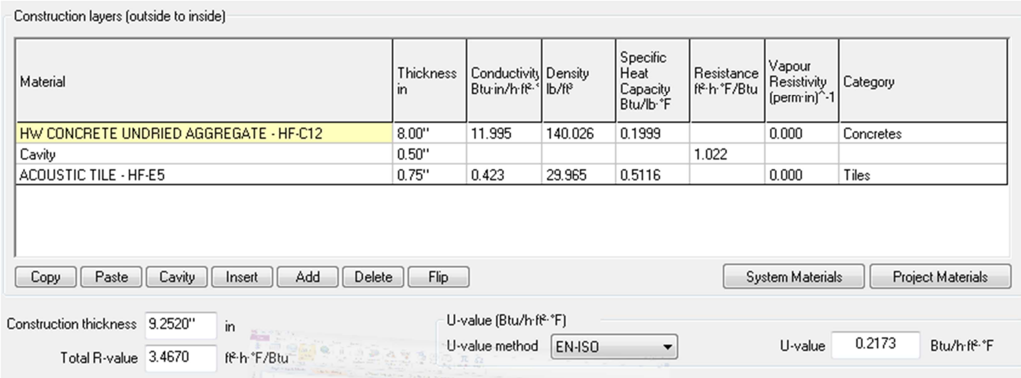
3. Glazing – The profile GEHC-AFG External was created utilizing data from LBNL’s WINDOWS program, with a net U-Value (including frame) of 0.3747 BTU/h ℉ ft ^{2} and a Visible Light Transmittance of 0.455.


Construction layers (outside to inside)

Description	Thickness (in)	Conductivity Btu·in/h·ft²·°F	Type of glass or blind	Gas	Convection coefficient Btu/h·ft²·°F	Resistance (ft²·h·°F/Btu)	Transmittance	Outside reflectance	Inside reflectance	Refractive index	Outside emissivity	Inside emissivity
Comfort E-PS Low e	0.12"	6.940	Inside film				0.688	0.120	0.119	1.526	0.148	0.840
Cavity	0.47"			Air	0.366	2.014						
Comfort E-PS Low e	0.12"	6.940	Uncoated				0.688	0.120	0.119	1.526	0.148	0.840

Figure 13 - GEHC-AFG External glazing Assumptions

4. Ceiling – The ceiling was assumed to be an 8” Heavy Weight Concrete Deck with False Ceiling with a U-Value of 0.2173 BTU/h ℉ ft ^{2}.



Construction layers (outside to inside)

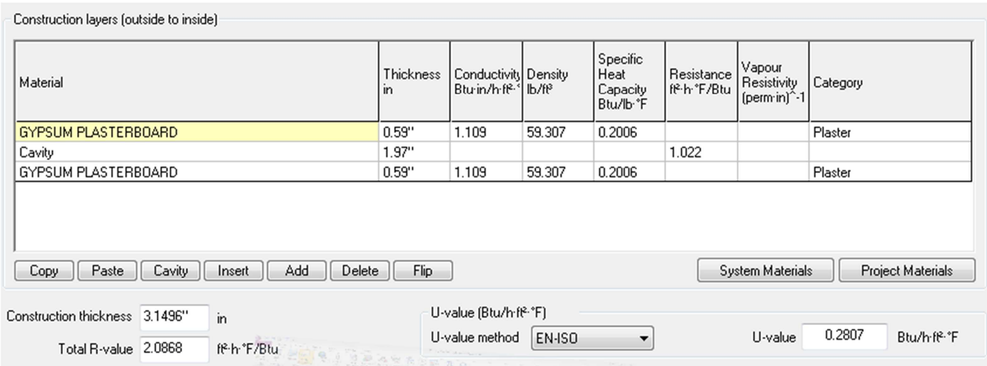
Material	Thickness in	Conductivity Btu·in/h·ft²·°F	Density lb/ft³	Specific Heat Capacity Btu/lb·°F	Resistance ft²·h·°F/Btu	Vapour Resistivity (perm·in)^-1	Category
HW CONCRETE UNDRIED AGGREGATE - HF-C12	8.00"	11.995	140.026	0.1999		0.000	Concretes
Cavity	0.50"				1.022		
ACOUSTIC TILE - HF-E5	0.75"	0.423	29.965	0.5116		0.000	Tiles

Copy Paste Cavity Insert Add Delete Flip System Materials Project Materials

Construction thickness 9.2520" in
Total R-value 3.4670 ft²·h·°F/Btu
U-value (Btu/h·ft²·°F)
U-value method EN-ISO
U-value 0.2173 Btu/h·ft²·°F

Figure 14 - Ceiling Assumptions

5. Internal Partitions – The internal partitions were assumed to be Lightweight Plasterboard partitions with a U-Value of 0.2806 BTU/h ℉ ft ^{2}.



Construction layers (outside to inside)

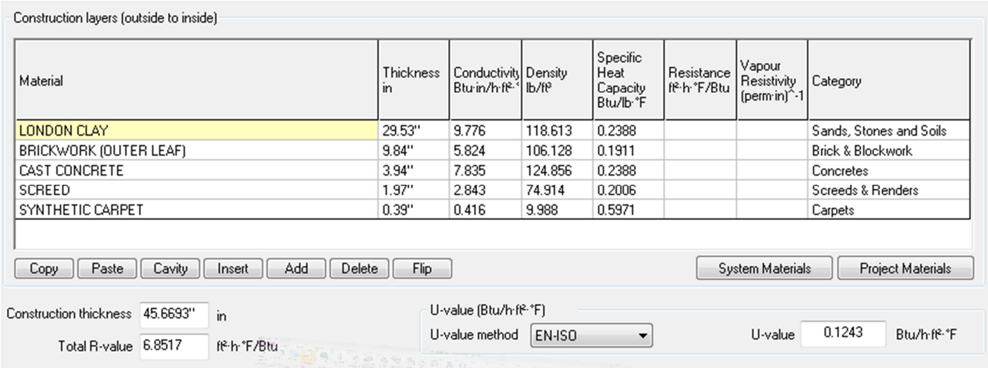
Material	Thickness in	Conductivity Btu·in/h·ft²·°F	Density lb/ft³	Specific Heat Capacity Btu/lb·°F	Resistance ft²·h·°F/Btu	Vapour Resistivity (perm·in)^-1	Category
GYPSUM PLASTERBOARD	0.59"	1.109	59.307	0.2006			Plaster
Cavity	1.97"				1.022		
GYPSUM PLASTERBOARD	0.59"	1.109	59.307	0.2006			Plaster

Copy Paste Cavity Insert Add Delete Flip System Materials Project Materials

Construction thickness 3.1496" in
Total R-value 2.0868 ft²·h·°F/Btu
U-value (Btu/h·ft²·°F)
U-value method EN-ISO
U-value 0.2807 Btu/h·ft²·°F

Figure 15 - Internal Partition Assumptions

6. Floors – The floors were assumed to be Un-insulated Solid-Ground floors with a U-Value of 0.1243 BTU/h ℉ ft ^{2}.



Construction layers (outside to inside)

Material	Thickness in	Conductivity Btu·in/h·ft^2·	Density lb/ft^3	Specific Heat Capacity Btu/lb·°F	Resistance ft^2·h·°F/Btu	Vapour Resistivity (perm·in)^-1	Category
LONDON CLAY	29.53"	9.776	118.613	0.2388			Sands, Stones and Soils
BRICKWORK (OUTER LEAF)	9.84"	5.824	106.128	0.1911			Brick & Blockwork
CAST CONCRETE	3.94"	7.835	124.856	0.2388			Concretes
SCREED	1.97"	2.843	74.914	0.2006			Screeds & Renders
SYNTHETIC CARPET	0.39"	0.416	9.988	0.5971			Carpets

Figure 16 - Un-insulated Solid-ground Floor Assumptions

7. Doors – The doors were assumed to be Generic Wood Doors with a U-Value of 0.3865 BTU/h ℉ ft^2.

Assumptions about Thermal Conditions

A separate thermal template was created for each zone with individually specified setpoints and schedules for heating and cooling.

1. Bridge Area Template – The Bridge Area was modeled with a cooling setpoint of 72F/85F Setback and a heating initialization point of 64F.

2. Classroom/Lecture/Training – The Classroom/Lecture/Training Area was modeled with a cooling setpoint of 72F/85F Setback and a heating initialization point of 64F.

3. Corridor/Transition – The Corridor/Transition Area was modeled with a cooling setpoint of 75F/85F Setback and a heating initialization point of 61F.

4. Customer Area – The Customer Area was modeled with a cooling setpoint of 72F/85F Setback and a heating initialization point of 64F.
5. Dining Area/Lounge/Leisure Dining – The Dining Area/Lounge/Leisure Dining was modeled with a cooling setpoint of 72F/85F Setback and a heating initialization point of 68F
6. Electrical/Mechanical Area – The Electrical/Mechanical Area was considered unconditioned.
7. Elevator Lobbies – The Elevator lobbies were modeled with a cooling setpoint of 70F/85F Setback and a heating initialization point of 68F
8. Lobby/Performing Arts/Theater - The Lobby/Performing Arts/Theater was modeled with a cooling setpoint of 70F/85F Setback and a heating initialization point of 68F
9. Medium or Bulky Material Warehouse - The Medium or Bulky Material Warehouse was modeled with a cooling setpoint of 75F/85F Setback and a heating initialization point of 57F
10. Enclosed Office - The Enclosed Office was modeled with a cooling setpoint of 72F/85F Setback and a heating initialization point of 70F
11. Open Plan Office - The Open Plan Office was modeled with a cooling setpoint of 72F/85F Setback and a heating initialization point of 70F

12. Playing Area/Exercise Center - The Playing Area/Exercise Center was modeled with a cooling setpoint of 70F/85F Setback and a heating initialization point of 65F

13. Restrooms - The Restrooms were modeled with a cooling setpoint of 75F/85F Setback and a heating initialization point of 64F

14. Workshops - The Workshops were modeled with a cooling setpoint of 72F/85F Setback and a heating initialization point of 64F

Assumptions about HVAC Systems

The HVAC system was modeled in the ApacheHVAC module of IES-VE Pro 6.4, based on the system modeled in the eQuest LEED model. Three chillers were modeled, and the VAV system was modeled as a 100% exhausted system with no mixing, in order to reflect the current operating conditions.

Assumptions about Internal Gains

A separate set of internal gains was created for each zone with individually specified values for people, lighting, computers and miscellaneous gains. The gains were calculated from the number of light fixtures and equipment known to be in each zone.

Table 4 - Assumptions about Internal Gains

Template	**Internal Gains**
Bridge Area	Miscellaneous Gains = 1 W/ft^2 Occupant Density = 50 ft^2/person Fluorescent Lighting = 0.9 W/ft^2 Incandescent Lighting = 0.666 W/ft^2 Computers = 1 W/ft^2
Classroom/Lecture/Training	Miscellaneous Gains = 1 W/ft^2 Occupant Density = 25 ft^2/person Fluorescent Lighting = 0.771 W/ft^2 Incandescent Lighting = 1.722 W/ft^2 Computers = 0.3 W/ft^2
Corridor/Transition	Occupant Density = 1075 ft^2/person Fluorescent Lighting = 1.369 W/ft^2

Table 4 - Assumptions about Internal Gains Contd.

Table 4 - Assumptions about Internal Gains Contd.

Template	**Internal Gains**
Customer Area	Miscellaneous Gains = 0.25 W/ft^2 Occupant Density = 100 ft^2/person Fluorescent Lighting = 0.7 W/ft^2 Incandescent Lighting = 0.764 W/ft^2 Computers = 0.446 W/ft^2
Dining Area/Lounge/Leisure Dining	Occupant Density = 25 ft^2/person Fluorescent Lighting = 0.692 + 0.161 W/ft^2 Incandescent Lighting = 0.920 W/ft^2
Electrical/Mechanical Area	Occupant Density = 500 ft^2/person Fluorescent Lighting = 1.184 W/ft^2 Computers = 2.222 W/ft^2
Elevator Lobbies	Miscellaneous Gains = 0.25 W/ft^2 Occupant Density = 100 ft^2/person Fluorescent Lighting = 1.1 W/ft^2

Table 4 - Assumptions about Internal Gains Contd.

Template	**Internal Gains**
Lobby/Performing Arts/Theater	Occupant Density = 25 ft^2/person Fluorescent Lighting = 0.465 W/ft^2 + 0.050 W/ft^2 + 0.149 W/ft^2 (Three different types of light fixtures) Incandescent Lighting = 0.664 W/ft^2
Medium or Bulky Material Warehouse	Occupant Density = 500 ft^2/person Fluorescent Lighting = 1.8 W/ft^2
Enclosed Office	Miscellaneous Gains = 1 W/ft^2 Occupant Density = 125 ft^2/person Fluorescent Lighting = 1.35 W/ft^2 Computers = 1.12 W/ft^2
Open Plan Office	Miscellaneous Gains = 1 W/ft^2 Occupant Density = 125 ft^2/person Fluorescent Lighting = 1.35 W/ft^2 Computers = 1.12 W/ft^2

Table 4 - Assumptions about Internal Gains Contd.

Template	**Internal Gains**
Playing Area/Exercise Center	Occupant Density = 100 ft^2/person Fluorescent Lighting = 1.5 W/ft^2 Incandescent Lighting = 0.674 W/ft^2
Restrooms	Occupant Density = 1000 ft^2/person Fluorescent Lighting = 0.9 W/ft^2
Workshops	Miscellaneous Gains = 1.5 W/ft^2 Occupant Density = 100 ft^2/person Fluorescent Lighting = 1.4 W/ft^2

Assumptions about Artificial Lighting

The following is the enumerated list of light fitting and their consumption specifications. For more details see Appendix C. Actual IESNA data for the light fixtures was used wherever possible, with Lightolier being the supplier of choice.

1. Lightolier B : 2-F32T8-3500K at 277V and 70W

2. Lightolier F : 1-F17T8-3500K at 277V and 20W

3. Lightolier F1 : 1-F17T8-3500K at 277V and 20W
4. Lightolier LF1 : 2-F28T5-830K at 120V and 56W
5. Lightolier LJ1 : 1-F32T8X/SPX30/A/4P at 120V and 32W
6. Lightolier LT1 : 100PAR.HIR/FL at 120V and 100W
7. Lightolier LT2 : 100PAR.HIR/SP at 120V and 100W
8. Lightolier LT3 : 1-F28T5-830K at 120V and 28W
9. Lightolier P1 : 3-F32T8-3500K at 277V and 105W
10. Lightolier P1X : 2-F32T8-3500K at 277V and 70W
11. Lightolier V : 2-F32T8-3500K at 277V and 70W

Assumptions about Infiltration

The infiltration in all zones was assumed to be a standard 0.167 ach.

Profiles in the IES-VE Model

Two types of profiles may be created in IES-VE –

- Absolute – Where numeric values with either IP or Metric units may be specified.
- Modulating – Where toggle values (On/Off) may be specified.

The profiles created in IES-VE have been categorized as follows –

1. Daily Profiles
2. Weekly Profiles
3. Annual Profiles

Daily Profiles

The following Daily Profiles were created –

1. GEHC-Current Operations-No After Hour Events (Modulating) = 7 AM **On** – 6 PM **Off**
2. GEHC-Current Operations- After Hour Events (Absolute) = 7 AM – 11 PM at **72F**
3. GEHC-Current Operations- No After Hour Events (Absolute) = 7 AM – 7 PM at **72F**
4. GEHC-Current Operations- Only After Hour Events (Absolute) = 2 PM – 11 PM at **72F**
5. GEHC-Current Operations- After Hour Events (Modulating) = 7 AM **On** – 11 PM **Off**
6. GEHC-Current Operations-Only After Hour Events (Modulating) = 2 PM **On** – 11 PM **Off**

Weekly Profiles

The following Weekly Profiles were created –

1. GEHC-Regular Week-Heavy : Full 7 day week with After Hours from Thursday to Sunday

2. GEHC-Regular Week-Light : Full 5 day week with no After Hours at all

Annual Profiles

The following Annual Profiles were created –

1. GEHC-Current Operation: Full 12 months of the GEHC-Regular Week-Heavy schedule.

CHAPTER 6

ANALYSIS OF THE NEW MODEL

The new energy model was simulated using the ApacheSim module in the software package IES-VE Pro version 6.4, using the assumptions detailed in the previous chapter. For detailed output from simulation, see Appendix F

Overall Energy Consumption

The results of simulating the building with settings as close as possible to its current operating pattern show an annual energy consumption of **2669233 KWh** at **51.5 KWh/ft^2**. This is now our energy consumption baseline.

Comparison with Previous Predictions and Actual Usage Data

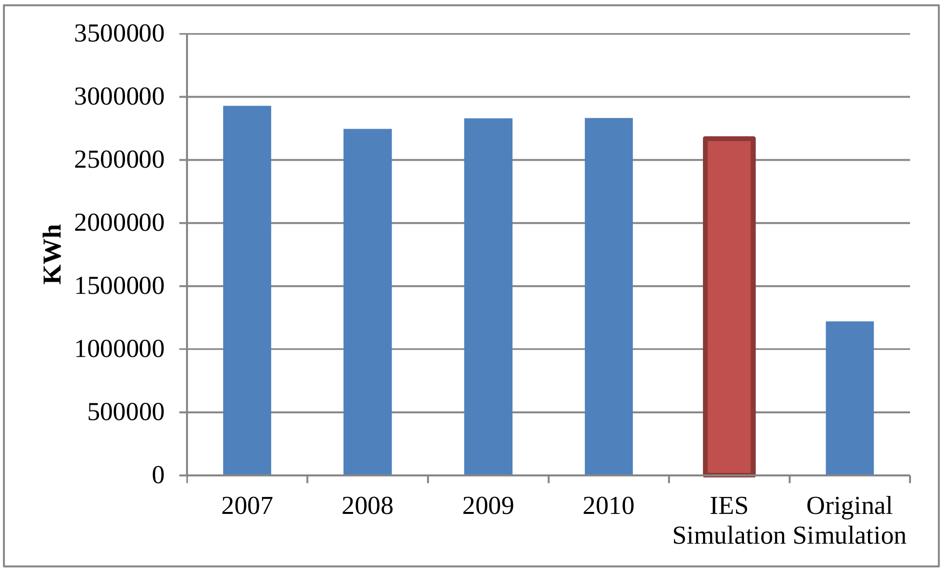


Figure 17 - Comparison of Simulated Results with Actual Usage Data

When comparing with both the previous predicted usage and the actual usage, we find that the results of this simulation are within 17% of the Actual Usage numbers. The results from the IES as-is simulation show a marked increase over the eQuest predictive simulation for the following reasons –

1. Three chillers were modeled, instead of one in the predictive model.

2. All air removed from a space was exhausted to the outside, with no air returned to the air handler. All air supplied to the individual spaces was supplied from the outside. This was inferred from the control systems drawings available at the facility, which showed that the HVAC system was operated similar to this assumption.

3. The Lighting Power Density (LPD) was calculated using the actual number and rating of the fixtures in each zone in the IES Model, unlike the eQuest model where all incandescent lighting was assumed to be 1 W/ft^2 due to ASHRAE 90.1 1999 Chapter 11 constraints.

4. No occupancy sensors were modeled in the IES model, while occupancy sensors were modeled as a 15% reduction in lighting power density (LPD) in line with ASHRAE 90.1 1999 Chapter 11 recommendations.

5. A heavier schedule of usage and occupancy, reflective of the current usage and occupancy of the facility, was used in the IES model.

6. The IES model includes the finished out lower level, which was not included in the eQuest model.

Overview of Energy Consumed by Lighting

Table 5 - Monthly Lighting Energy

Month	**KWh**
January	41946.6
February	39147.9
March	44797.7
April	41825
May	42491.3
June	42914.4
July	42555.1
August	43644.5
September	42369.7
October	41946.6
November	42914.4
December	43708.3
Total	**510261.5**

Lighting as a Percentage of the Total Consumption

As a percentage of total consumption, lighting accounts for **19.1%** of consumption.

At a rate of 8.29 cents/Kwh, this costs the GEHC **$40,820.92** every year.

These are the results from the simulation. If proportionally upgraded to be the same percentage of consumption of the actual consumption of the facility, the energy consumed by lighting every year would be **540877 KWh**, which accounts for **$43,270.16** of their annual utility bill.

Daylighting Analysis of a Sample Zone

The daylighting analysis was performed using the RadianceIES module in the software package IES-VE Pro version 6.4. The Bridge was chosen as the sample zone, and the north bay was analyzed for illuminance levels three times each day – 9:00 AM, 12:00 PM and 4:00 PM – for 15th of every month.

Purpose of Analysis

As we realized in Chapter 4 and after the consumption analysis in Chapter 6, the lighting schedules provide the most cost-effective area for optimization interventions. As an internally-driven building, meaning a building whose consumption is mostly driven by internal gains, occupancy and systems, rather than external gains from the envelope, very little improvement can be had by optimization of the envelope, which contributes only 1050947.7 Kwh (15%) of the

6927056.38 Kwh heating and cooling load (See Appendices G and H). This daylighting analysis aims to establish that the space possesses sufficient illumination levels to warrant a reduction the use of artificial lighting, thus enabling a reduction in energy consumption. For the activities that occur in this space, a nominal amount of 100 lux is sufficient.

Overall Conclusion

From the daylighting analysis, we see that the bridge is daylight sufficient from 9:00 Am to 4:00 PM throughout the year. This is supplemented by the fact that the static and interactive displays provide their own light and thus augment the amount of light in the space. We may thus confidently recommend reductions in artificial lighting during these timeframes.

CHAPTER 7

RECOMMENDATIONS TO REDUCE ENERGY USE

Recommendations

As per our findings in the previous chapter, all recommendations are limited to the lighting schedules, with the objective of taking advantage of excellent daylighting available in most zones in the top floor

Changes in Lighting Schedules

New lighting profiles are created for use in zones that receive good daylighting, such that artificial lighting is only active from 7:00 AM to 9:00 AM and after 4:00 PM.

Modeling the Changes in Lighting Schedules

New lighting profiles are created for use in zones that receive good daylighting, such that artificial lighting is only active from 7:00 AM to 9:00 AM and after 4:00 PM.

Daily Profiles

The following Daily Profiles are created –

1. GEHC-Recommendations-No After Hour Events (Modulating) = 7 AM **On** – 9 AM **Off** – 4 PM **On** – 6 PM **Off**

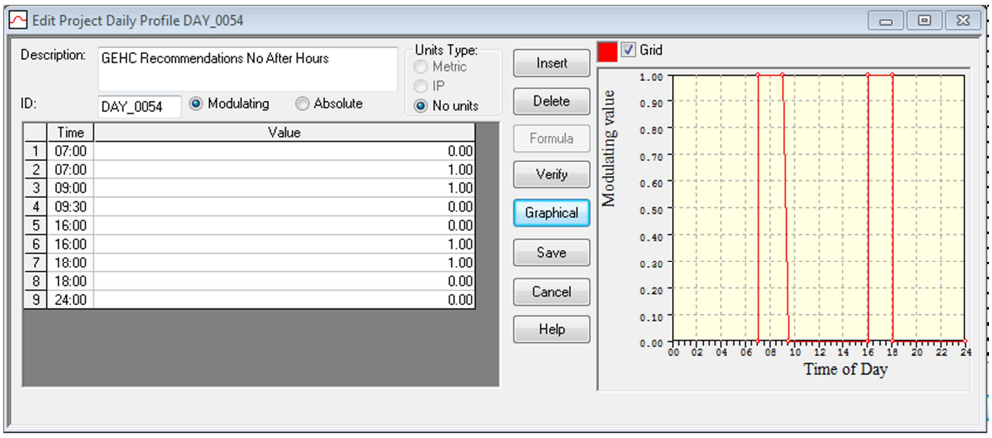


Figure 18 - GEHC-Recommendations-No After Hours-Profile

2. GEHC-Recommendations- After Hour Events (Modulating) = 7 AM **On** – 9 AM **Off** – 4 PM **On** – 11 PM **Off**

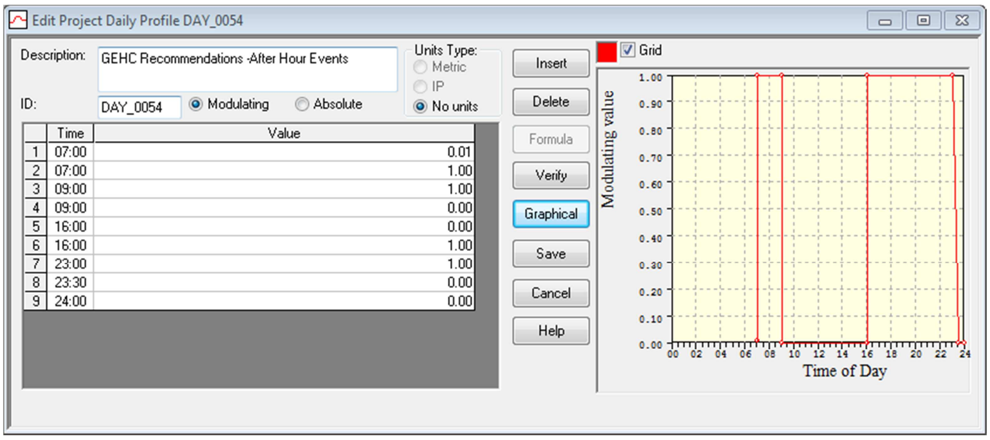


Figure 19 - GEHC-Recommendations-After Hour Events-Profile

Weekly Profiles

The following Weekly Profiles were created –

1. GEHC-Recommendations-Heavy Week : Full 7 day week with After Hours from Thursday to Sunday

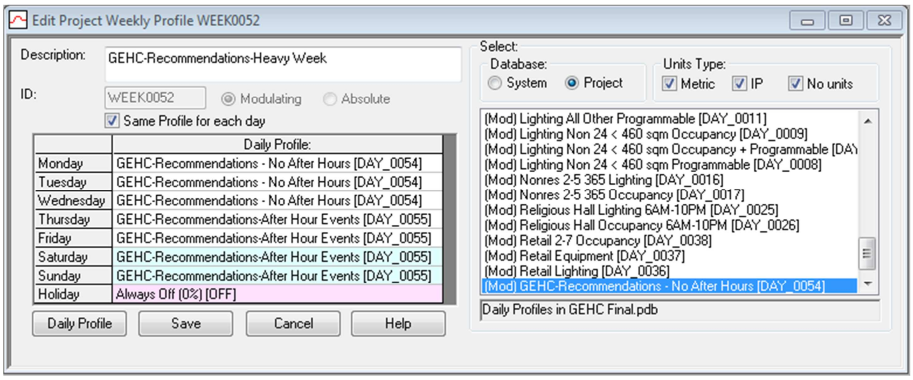


Figure 20 - GEHC-Recommendations-Heavy Week-Profile

Annual Profiles

The following Annual Profiles were created –

1. GEHC-Recommendations: Full 12 months of the GEHC-Regular Week-Heavy schedule.

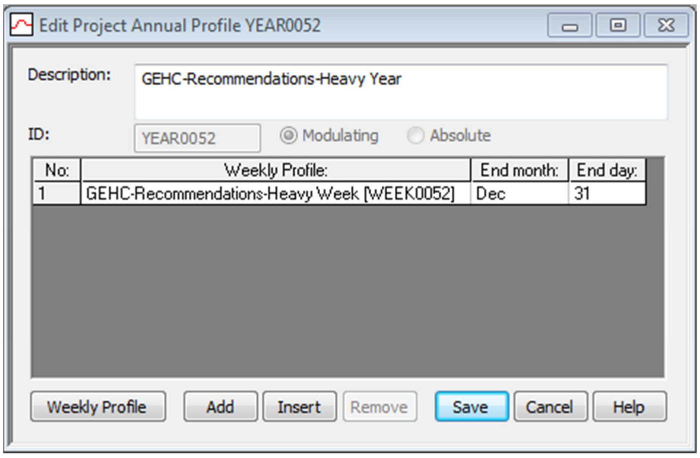


Figure 21 - GEHC-Recommendations-Heavy Year-Profile

Results of the Simulation of Recommendations

Overall Energy Consumption (Refer Appendix G for Detailed Output)

We find that the overall annual energy consumption has been reduced to 2404795 KWh.

Overall Lighting Energy Consumption (Refer Appendix G for Detailed Output)

We find that the overall annual energy consumed by lighting has been reduced to 247789 KWh.

CHAPTER 8

ANALYSIS OF RESULTS

Analysis of Results

As we have established previously that the results of simulating the energy consumption of this facility as operated are not too far off from the actual consumption data, we may reasonably conclude that the savings resulting from the optimization recommendations will not be too far off from those achieved in reality, as a percentage of the actual consumption.

Overview of Results

After the implementation of the lighting reduction recommendations, the overall energy use has decreased from 2669233 KWh to 2404795 KWh. This represents a **decrease of 10%** and translates into an **annual savings of $21,155.05** at a rate of $0.08292/KWh.

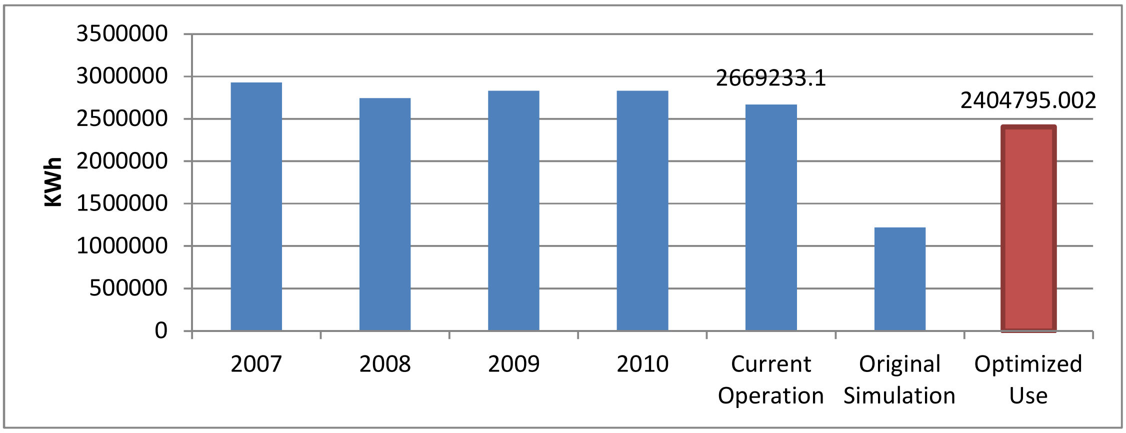


Figure 22 - Overall Comparison of Derived and Actual Consumption Values

CHAPTER 9

CONCLUSION

Summary of Results

Through building simulation methods, a simulated baseline consumption level of the building, as currently operated, was established as 2669223 KWh/year. Recommendations were made to reduce consumption, and the results of the simulation of these recommendations yielded a 10% reduction in consumption annually, translating into an annual savings of $21,155.05 at a utility rate of $0.08292/KWh. This rate was calculated by the simple procedure of dividing the facility's previous annual consumption by their annual expenditure on electric power.

Thoughts on the Procedure of the Study

In keeping with the objective of reducing the energy consumption of the GEHC using solely the manipulation of operation schedules, without any other interventions, this study exclusively uses building simulation as the tool with which to predict savings.

Building simulation tools, however, provide little or no insight into their core methodologies – they are virtually 'black boxes' [7] offering control only over the assumptions and inputs incorporated into the building model, and interactions are inferred rather than illuminated. This creates an inability to map any changes in assumptions directly to consequences in consumption, making the prediction of the effectiveness of any optimization recommendations more an art than a science. The simulation programs also simplify the operation of the building into a series of presets, which do not account for the far greater complexity associated with the actual operation and occupancies of a building, thus introducing another element of uncertainty into the final predictions.

The same holds true for the daylighting analysis performed using the RadianceIES module of IES-VE Pro 6.4, which is itself based on a software program called Radiance, developed by the Lawrence Berkeley National Laboratories. There is no measure of the accuracy of this software, though it is widely used in the industry, and it has been out of development since 2002.

APPENDIX A

DETAILS OF THE ASSUMPTIONS MADE IN THE ORIGINAL EQUEST MODEL

Categorization of the Assumptions made in the original eQuest Model

The assumptions made in the original eQuest model have been categorized as follows –

1. Annual Schedules
2. Weekly Schedules
3. Daily Schedules
4. Building and Shell
5. Water-side HVAC
6. Air-side HVAC
7. Meters

The assumptions are presented in a tabulated form using all original naming and settings found in the model.

Annual Schedules

Table 6. Annual Schedules

Annual Schedule	Week Schedule	Ending Month	Ending Day
Grnd Flr Occ Sch	Grnd Flr Occ 1/0 W1	12	31
Grnd Flr Ltg Sch	Grnd Flr Ltg 1/0 W1	12	31
Grnd Flr Eqp Sch	Grnd Flr Eqp 1/0 W1	12	31
Grnd Flr Sys1 Cool Sch	Grnd Flr Sys1 Cool 1/0 W1	12	31
Grnd Flr Sys1 Heat Sch	Grnd Flr Sys1 Heat 1/0 W1	12	31
Grnd Flr Sys1 Infil Sch	Grnd Flr Sys1 Infil 1/0 W1	12	31
Top Flr Occ Sch	Top Flr Occ 1/0 W1	12	31
Top Flr Ltg Sch	Top Flr Ltg 1/0 W1	12	31
Top Flr Eqp Sch	Top Flr Eqp 1/0 W1	12	31
Top Flr Sys1 Cool Sch	Top Flr Sys1 Cool 1/0 W1	12	31
Top Flr Sys1 Heat Sch	Top Flr Sys1 Heat 1/0 W1	12	31
Top Flr Sys1 Infil Sch	Top Flr Sys1 Infil 1/0 W1	12	31
Sys1 (VAVS) Fan Sch	Sys1 (VAVS) Fans W1	12	31
Custom Elec Season Sched	Custom Elec Seas1 Week	12	31
Custom Gas Season Sched	Custom Gas Seas1 Week	12	31
Annual Schedule 17	Week Schedule ON/OFF	12	31
ratchet schedule	ratchweek	12	31
Sh	Week Schedule ON/OFF	12	31
OS lighting SCH	OS lighting W1	12	31
Dirt Depre Windows	Dirt Win WK	12	31
Schedule ON/OFF	Week Schedule ON/OFF	12	31

Weekly Schedules

Table 7. Weekly Schedules

Week Schedule Name	Schedule Type	Monday Schedule	Tuesday Schedule	Wednesday Schedule
Grnd Flr Occ 1/0 W1	Fraction	Grnd Flr Occ 1/0 D2	Grnd Flr Occ 1/0 D2	Grnd Flr Occ 1/0 D2
Grnd Flr Ltg 1/0 W1	Fraction	Grnd Flr Ltg 1/0 D2	Grnd Flr Ltg 1/0 D2	Grnd Flr Ltg 1/0 D2
Grnd Flr Eqp 1/0 W1	Fraction	Grnd Flr Eqp 1/0 D2	Grnd Flr Eqp 1/0 D2	Grnd Flr Eqp 1/0 D2
Top Flr Occ 1/0 W1	Fraction	Top Flr Occ 1/0 D2	Top Flr Occ 1/0 D2	Top Flr Occ 1/0 D2
Top Flr Ltg 1/0 W1	Fraction	Top Flr Ltg 1/0 D2	Top Flr Ltg 1/0 D2	Top Flr Ltg 1/0 D2
Top Flr Eqp 1/0 W1	Fraction	Top Flr Eqp 1/0 D2	Top Flr Eqp 1/0 D2	Top Flr Eqp 1/0 D2
OS lighting W1	Fraction	OS lighting D2	OS lighting D2	OS lighting D2
Dirt Win WK	Fraction	Dirt Win DY	Dirt Win DY	Dirt Win DY
Grnd Flr Sys1 Cool 1/0 W1	Temperature	Grnd Flr Sys1 Cool 1/0 D2	Grnd Flr Sys1 Cool 1/0 D2	Grnd Flr Sys1 Cool 1/0 D2
Grnd Flr Sys1 Heat 1/0 W1	Temperature	Grnd Flr Sys1 Heat 1/0 D2	Grnd Flr Sys1 Heat 1/0 D2	Grnd Flr Sys1 Heat 1/0 D2
Top Flr Sys1 Cool 1/0 W1	Temperature	Top Flr Sys1 Cool 1/0 D2	Top Flr Sys1 Cool 1/0 D2	Top Flr Sys1 Cool 1/0 D2
Top Flr Sys1 Heat 1/0 W1	Temperature	Top Flr Sys1 Heat 1/0 D2	Top Flr Sys1 Heat 1/0 D2	Top Flr Sys1 Heat 1/0 D2
Grnd Flr Sys1 Infil 1/0 W1	Multiplier	Grnd Flr Sys1 Inf 1/0/1 D2	Grnd Flr Sys1 Inf 1/0/1 D2	Grnd Flr Sys1 Inf 1/0/1 D2
Top Flr Sys1 Infil 1/0 W1	Multiplier	Top Flr Sys1 Inf 1/0/1 D2	Top Flr Sys1 Inf 1/0/1 D2	Top Flr Sys1 Inf 1/0/1 D2
Sys1 (VAVS) Fans W1	On/Off	Sys1 (VAVS) Fans D1-2	Sys1 (VAVS) Fans D1-2	Sys1 (VAVS) Fans D1-2
ratchweek	On/Off	ratchday	ratchday	ratchday

Table 7 (Cont'd)

Table 7 (Cont'd)

Week Schedule Name	Schedule Type	Thursday Schedule	Friday Schedule	Saturday Schedule
Grnd Flr Occ 1/0 W1	Fraction	Grnd Flr Occ 1/0 D2	Grnd Flr Occ 1/0 D2	Grnd Flr Occ 1/0 D1
Grnd Flr Ltg 1/0 W1	Fraction	Grnd Flr Ltg 1/0 D2	Grnd Flr Ltg 1/0 D2	Grnd Flr Ltg 1/0 D2
Grnd Flr Eqp 1/0 W1	Fraction	Grnd Flr Eqp 1/0 D2	Grnd Flr Eqp 1/0 D2	Grnd Flr Eqp 1/0 D1
Top Flr Occ 1/0 W1	Fraction	Top Flr Occ 1/0 D2	Top Flr Occ 1/0 D2	Top Flr Occ 1/0 D1
Top Flr Ltg 1/0 W1	Fraction	Top Flr Ltg 1/0 D2	Top Flr Ltg 1/0 D2	Top Flr Ltg 1/0 D1
Top Flr Eqp 1/0 W1	Fraction	Top Flr Eqp 1/0 D2	Top Flr Eqp 1/0 D2	Top Flr Eqp 1/0 D1
OS lighting W1	Fraction	OS lighting D2	OS lighting D2	OS lighting D1
Dirt Win WK	Fraction	Dirt Win DY	Dirt Win DY	Dirt Win DY
Grnd Flr Sys1 Cool 1/0 W1	Temperature	Grnd Flr Sys1 Cool 1/0 D2	Grnd Flr Sys1 Cool 1/0 D2	Grnd Flr Sys1 Cool 1/0 D1
Grnd Flr Sys1 Heat 1/0 W1	Temperature	Grnd Flr Sys1 Heat 1/0 D2	Grnd Flr Sys1 Heat 1/0 D2	Grnd Flr Sys1 Heat 1/0 D1
Top Flr Sys1 Cool 1/0 W1	Temperature	Top Flr Sys1 Cool 1/0 D2	Top Flr Sys1 Cool 1/0 D2	Top Flr Sys1 Cool 1/0 D1
Top Flr Sys1 Heat 1/0 W1	Temperature	Top Flr Sys1 Heat 1/0 D2	Top Flr Sys1 Heat 1/0 D2	Top Flr Sys1 Heat 1/0 D1
Grnd Flr Sys1 Infil 1/0 W1	Multiplier	Grnd Flr Sys1 Inf 1/0/1 D2	Grnd Flr Sys1 Inf 1/0/1 D2	Grnd Flr Sys1 Inf 1/0/1 D1
Top Flr Sys1 Infil 1/0 W1	Multiplier	Top Flr Sys1 Inf 1/0/1 D2	Top Flr Sys1 Inf 1/0/1 D2	Top Flr Sys1 Inf 1/0/1 D1
Sys1 (VAVS) Fans W1	On/Off	Sys1 (VAVS) Fans D1-2	Sys1 (VAVS) Fans D1-2	Sys1 (VAVS) Fans D1-1
ratchweek	On/Off	ratchday	ratchday	ratchday

Table 7 (Cont'd)

Table 7 (Cont'd)

Week Schedule Name	Schedule Type	Sunday Schedule	Holiday Schedule
Grnd Flr Occ 1/0 W1	Fraction	Grnd Flr Occ 1/0 D1	Grnd Flr Occ 1/0 D1
Grnd Flr Ltg 1/0 W1	Fraction	Grnd Flr Ltg 1/0 D2	Grnd Flr Ltg 1/0 D1
Grnd Flr Eqp 1/0 W1	Fraction	Grnd Flr Eqp 1/0 D1	Grnd Flr Eqp 1/0 D1
Top Flr Occ 1/0 W1	Fraction	Top Flr Occ 1/0 D1	Top Flr Occ 1/0 D1
Top Flr Ltg 1/0 W1	Fraction	Top Flr Ltg 1/0 D1	Top Flr Ltg 1/0 D1
Top Flr Eqp 1/0 W1	Fraction	Top Flr Eqp 1/0 D1	Top Flr Eqp 1/0 D1
OS lighting W1	Fraction	OS lighting D1	OS lighting D1
Dirt Win WK	Fraction	Dirt Win DY	Dirt Win DY
Grnd Flr Sys1 Cool 1/0 W1	Temperature	Grnd Flr Sys1 Cool 1/0 D1	Grnd Flr Sys1 Cool 1/0 D1
Grnd Flr Sys1 Heat 1/0 W1	Temperature	Grnd Flr Sys1 Heat 1/0 D1	Grnd Flr Sys1 Heat 1/0 D1
Top Flr Sys1 Cool 1/0 W1	Temperature	Top Flr Sys1 Cool 1/0 D1	Top Flr Sys1 Cool 1/0 D1
Top Flr Sys1 Heat 1/0 W1	Temperature	Top Flr Sys1 Heat 1/0 D1	Top Flr Sys1 Heat 1/0 D1
Grnd Flr Sys1 Infil 1/0 W1	Multiplier	Grnd Flr Sys1 Inf 1/0/1 D1	Grnd Flr Sys1 Inf 1/0/1 D1
Top Flr Sys1 Infil 1/0 W1	Multiplier	Top Flr Sys1 Inf 1/0/1 D1	Top Flr Sys1 Inf 1/0/1 D1
Sys1 (VAVS) Fans W1	On/Off	Sys1 (VAVS) Fans D1-1	Sys1 (VAVS) Fans D1-1
ratchweek	On/Off	ratchday	ratchday

Table 7 (Cont'd)

Table 7(Cont'd)

Week Schedule Name	Schedule Type	Heating Design Day Schedule	Cooling Design Day Schedule
Grnd Flr Occ 1/0 W1	Fraction	Grnd Flr Occ 1/0 D2	Grnd Flr Occ 1/0 D2
Grnd Flr Ltg 1/0 W1	Fraction	Grnd Flr Ltg 1/0 D2	Grnd Flr Ltg 1/0 D2
Grnd Flr Eqp 1/0 W1	Fraction	Grnd Flr Eqp 1/0 D2	Grnd Flr Eqp 1/0 D2
Top Flr Occ 1/0 W1	Fraction	Top Flr Occ 1/0 D2	Top Flr Occ 1/0 D2
Top Flr Ltg 1/0 W1	Fraction	Top Flr Ltg 1/0 D2	Top Flr Ltg 1/0 D2
Top Flr Eqp 1/0 W1	Fraction	Top Flr Eqp 1/0 D2	Top Flr Eqp 1/0 D2
OS lighting W1	Fraction	OS lighting D2	OS lighting D2
Dirt Win WK	Fraction	Dirt Win DY	Dirt Win DY
Grnd Flr Sys1 Cool 1/0 W1	Temperature	Grnd Flr Sys1 Cool 1/0 D2	Grnd Flr Sys1 Cool 1/0 D2
Grnd Flr Sys1 Heat 1/0 W1	Temperature	Grnd Flr Sys1 Heat 1/0 D2	Grnd Flr Sys1 Heat 1/0 D2
Top Flr Sys1 Cool 1/0 W1	Temperature	Top Flr Sys1 Cool 1/0 D2	Top Flr Sys1 Cool 1/0 D2
Top Flr Sys1 Heat 1/0 W1	Temperature	Top Flr Sys1 Heat 1/0 D2	Top Flr Sys1 Heat 1/0 D2
Grnd Flr Sys1 Infil 1/0 W1	Multiplier	Grnd Flr Sys1 Inf 1/0/1 D2	Grnd Flr Sys1 Inf 1/0/1 D2
Top Flr Sys1 Infil 1/0 W1	Multiplier	Top Flr Sys1 Inf 1/0/1 D2	Top Flr Sys1 Inf 1/0/1 D2
Sys1 (VAVS) Fans W1	On/Off	Sys1 (VAVS) Fans D1-2	Sys1 (VAVS) Fans D1-2
ratchweek	On/Off	ratchday	ratchday

Daily Schedules

Table 8. Daily Schedules

Day Schedule Name	Day Schedule Type	Mdnt-1AM	1-2AM	2-3AM	3-4AM	4-5AM	5-6AM	6-7AM	7-8AM
Grnd Flr Occ 1/0 D1	Fractional	0	0	0	0	0	0	0	0
Grnd Flr Occ 1/0 D2	Fractional	0	0	0	0	0	0	0	0
Grnd Flr Ltg 1/0 D1	Fractional	0.0408	0.0408	0.0408	0.0408	0.0408	0.0408	0.0408	0.0408
Grnd Flr Ltg 1/0 D2	Fractional	0.0408	0.0408	0.0408	0.0408	0.0408	0.0408	0.0408	0.0408
Grnd Flr Eqp 1/0 D1	Fractional	0.1421	0.1421	0.1421	0.1421	0.1421	0.1421	0.1421	0.1421
Grnd Flr Eqp 1/0 D2	Fractional	0.1421	0.1421	0.1421	0.1421	0.1421	0.1421	0.1421	0.1421
Top Flr Occ 1/0 D1	Fractional	0	0	0	0	0	0	0	0
Top Flr Occ 1/0 D2	Fractional	0	0	0	0	0	0	0	0
Top Flr Ltg 1/0 D1	Fractional	0.0342	0.0342	0.0342	0.0342	0.0342	0.0342	0.0342	0.0342
Top Flr Ltg 1/0 D2	Fractional	0.0342	0.0342	0.0342	0.0342	0.0342	0.0342	0.0342	0.0342
Top Flr Eqp 1/0 D1	Fractional	0.1579	0.1579	0.1579	0.1579	0.1579	0.1579	0.1579	0.1579
Top Flr Eqp 1/0 D2	Fractional	0.1579	0.1579	0.1579	0.1579	0.1579	0.1579	0.1579	0.1579
OS lighting D1	Fractional	0.0142	0.0142	0.0142	0.0142	0.0142	0.0142	0.0142	0.0142
OS lighting D2	Fractional	0.0142	0.0142	0.0142	0.0142	0.0142	0.0142	0.0142	0.0142
Dirt Win DY	Fractional	1	1	1	1	1	1	1	1
Grnd Flr Sys1 Cool 1/0 D1	Temperature	82	82	82	82	82	82	82	82
Grnd Flr Sys1 Cool 1/0 D2	Temperature	82	82	82	82	82	82	77	72
Grnd Flr Sys1 Heat 1/0 D1	Temperature	55	55	55	55	55	55	55	55
Grnd Flr Sys1 Heat 1/0 D2	Temperature	55	55	55	55	55	55	60	63
Top Flr Sys1 Cool 1/0 D1	Temperature	82	82	82	82	82	82	82	82
Top Flr Sys1 Cool 1/0 D2	Temperature	82	82	82	82	82	82	77	72
Top Flr Sys1 Heat 1/0 D1	Temperature	55	55	55	55	55	55	55	55
Top Flr Sys1 Heat 1/0 D2	Temperature	55	55	55	55	55	55	60	63
Sys1 (VAVS) Fans D1-1	On/Off	0	0	0	0	0	0	0	0
Sys1 (VAVS) Fans D1-2	On/Off	0	0	0	0	0	0	1	1
ratchday	On/Off	1	1	1	1	1	1	1	1

Table 8 (Cont'd)

Day Schedule Name	Day Schedule Type	8-9AM	9-10AM	10-11AM	11AM-Noon	Noon-1PM	1-2PM	2-3PM	3-4PM
Grnd Flr Occ 1/0 D1	Fractional	0	0	0	0	0	0	0	0
Grnd Flr Occ 1/0 D2	Fractional	0	0	0.7	0.7	0.7	0.7	0.7	0.7
Grnd Flr Ltg 1/0 D1	Fractional	0.0408	0.0408	0.0408	0.0408	0.0408	0.0408	0.0408	0.0408
Grnd Flr Ltg 1/0 D2	Fractional	0.0408	0.4204	0.8	0.8	0.8	0.8	0.8	0.8
Grnd Flr Eqp 1/0 D1	Fractional	0.1421	0.1421	0.1421	0.1421	0.1421	0.1421	0.1421	0.1421
Grnd Flr Eqp 1/0 D2	Fractional	0.1421	0.1421	0.7	0.7	0.7	0.7	0.7	0.7
Top Flr Occ 1/0 D1	Fractional	0	0	0	0	0	0	0	0
Top Flr Occ 1/0 D2	Fractional	0	0	0.7	0.7	0.7	0.7	0.7	0.7
Top Flr Ltg 1/0 D1	Fractional	0.0342	0.0342	0.0342	0.0342	0.0342	0.0342	0.0342	0.0342
Top Flr Ltg 1/0 D2	Fractional	0.0342	0.4171	0.8	0.8	0.8	0.8	0.8	0.8
Top Flr Eqp 1/0 D1	Fractional	0.1579	0.1579	0.1579	0.1579	0.1579	0.1579	0.1579	0.1579
Top Flr Eqp 1/0 D2	Fractional	0.1579	0.1579	0.7	0.7	0.7	0.7	0.7	0.7
OS lighting D1	Fractional	0.0142	0.0142	0.0142	0.0142	0.0142	0.0142	0.0142	0.0142
OS lighting D2	Fractional	0.0142	0.3171	0.6	0.6	0.6	0.6	0.6	0.6
Dirt Win DY	Fractional	1	1	1	1	1	1	1	1
Grnd Flr Sys1 Cool 1/0 D1	Temperature	82	82	82	82	82	82	82	82
Grnd Flr Sys1 Cool 1/0 D2	Temperature	72	72	72	72	72	72	72	72
Grnd Flr Sys1 Heat 1/0 D1	Temperature	55	55	55	55	55	55	55	55
Grnd Flr Sys1 Heat 1/0 D2	Temperature	66	66	66	66	66	66	66	66
Top Flr Sys1 Cool 1/0 D1	Temperature	82	82	82	82	82	82	82	82
Top Flr Sys1 Cool 1/0 D2	Temperature	72	72	72	72	72	72	72	72
Top Flr Sys1 Heat 1/0 D1	Temperature	55	55	55	55	55	55	55	55
Top Flr Sys1 Heat 1/0 D2	Temperature	66	66	66	66	66	66	66	66
Sys1 (VAVS) Fans D1-1	On/Off	0	0	0	0	0	0	0	0
Sys1 (VAVS) Fans D1-2	On/Off	1	1	1	1	1	1	1	1
ratchday	On/Off	1	1	1	1	1	1	1	1

Table 8 (Cont'd)

Day Schedule Name	Day Schedule Type	4-5PM	5-6PM	6-7PM	7-8PM	8-9PM	9-10PM	10-11PM	11 Pm-Mdnt
Grnd Flr Occ 1/0 D1	Fractional	0	0	0	0	0	0	0	0
Grnd Flr Occ 1/0 D2	Fractional	0.7	0.7	0	0	0	0	0	0
Grnd Flr Ltg 1/0 D1	Fractional	0.0408	0.0408	0.0408	0.0408	0.0408	0.0408	0.0408	0.0408
Grnd Flr Ltg 1/0 D2	Fractional	0.8	0.8	0.0408	0.0408	0.0408	0.0408	0.0408	0.0408
Grnd Flr Eqp 1/0 D1	Fractional	0.1421	0.1421	0.1421	0.1421	0.1421	0.1421	0.1421	0.1421
Grnd Flr Eqp 1/0 D2	Fractional	0.7	0.7	0.1421	0.1421	0.1421	0.1421	0.1421	0.1421
Top Flr Occ 1/0 D1	Fractional	0	0	0	0	0	0	0	0
Top Flr Occ 1/0 D2	Fractional	0.7	0.7	0	0	0	0	0	0
Top Flr Ltg 1/0 D1	Fractional	0.0342	0.0342	0.0342	0.0342	0.0342	0.0342	0.0342	0.0342
Top Flr Ltg 1/0 D2	Fractional	0.8	0.8	0.4171	0.0342	0.0342	0.0342	0.0342	0.0342
Top Flr Eqp 1/0 D1	Fractional	0.1579	0.1579	0.1579	0.1579	0.1579	0.1579	0.1579	0.1579
Top Flr Eqp 1/0 D2	Fractional	0.7	0.7	0.1579	0.1579	0.1579	0.1579	0.1579	0.1579
OS lighting D1	Fractional	0.0142	0.0142	0.0142	0.0142	0.0142	0.0142	0.0142	0.0142
OS lighting D2	Fractional	0.6	0.6	0.3171	0.0142	0.0142	0.0142	0.0142	0.0142
Dirt Win DY	Fractional	1	1	1	1	1	1	1	1
Grnd Flr Sys1 Cool 1/0 D1	Temperature	82	82	82	82	82	82	82	82
Grnd Flr Sys1 Cool 1/0 D2	Temperature	72	72	82	82	82	82	82	82
Grnd Flr Sys1 Heat 1/0 D1	Temperature	55	55	55	55	55	55	55	55
Grnd Flr Sys1 Heat 1/0 D2	Temperature	66	66	55	55	55	55	55	55
Top Flr Sys1 Cool 1/0 D1	Temperature	82	82	82	82	82	82	82	82
Top Flr Sys1 Cool 1/0 D2	Temperature	72	72	82	82	82	82	82	82
Top Flr Sys1 Heat 1/0 D1	Temperature	55	55	55	55	55	55	55	55
Top Flr Sys1 Heat 1/0 D2	Temperature	66	66	55	55	55	55	55	55
Sys1 (VAVS) Fans D1-1	On/Off	0	0	0	0	0	0	0	0
Sys1 (VAVS) Fans D1-2	On/Off	1	1	1	0	0	0	0	0
ratchday	On/Off	1	1	1	1	1	1	1	1

Building and Shell

Table 9. Building and Shell

Space Name	Parent Floor	Zone Type	Activity/Desc	Temperature (F)	Occupancy Schedule
Ground Flr Classrm (G.SSW2)	Ground Flr	Conditioned	Exhibit Display / Museum (62%)	70	Grnd Flr Occ Sch
Mech 1 (G.WSW3)	Ground Flr	Conditioned	Exhibit Display / Museum (62%)	70	Grnd Flr Occ Sch
Mech 2 (G.E4)	Ground Flr	Conditioned	Exhibit Display / Museum (62%)	70	Grnd Flr Occ Sch
Conditioned Mech (G.S8)	Ground Flr	Conditioned	Exhibit Display / Museum (62%)	70	Grnd Flr Occ Sch
Mech 3 (G.WNW9)	Ground Flr	Conditioned	Exhibit Display / Museum (62%)	70	Grnd Flr Occ Sch
Blue Planet (T.E10)	Top Flr	Conditioned	Exhibit Display / Museum (62%)	70	Top Flr Occ Sch
Upper Classrms 1 (T.SSW11)	Top Flr	Conditioned	Exhibit Display / Museum (62%)	70	Top Flr Occ Sch
Upper Classrms 2 (T.WSW12)	Top Flr	Conditioned	Exhibit Display / Museum (62%)	70	Top Flr Occ Sch
Corridor1(T.E13)	Top Flr	Conditioned	Exhibit Display / Museum (62%)	70	Top Flr Occ Sch
Office (T.N14)	Top Flr	Conditioned	Exhibit Display / Museum (62%)	70	Top Flr Occ Sch
Corridor 2 (T.W15)	Top Flr	Conditioned	Exhibit Display / Museum (62%)	70	Top Flr Occ Sch
Display 1 (T.N16)	Top Flr	Conditioned	Exhibit Display / Museum (62%)	70	Top Flr Occ Sch
Corridor 3 (T.S17)	Top Flr	Conditioned	Exhibit Display / Museum (62%)	70	Top Flr Occ Sch
Display 2 (T.WNW18)	Top Flr	Conditioned	Exhibit Display / Museum (62%)	70	Top Flr Occ Sch

Table 9 (Cont'd)

Space Name	Area/Person (ft2)	Number of People	Total Heat Gain	People Sens	People Lat
				Btu/h-person	
Ground Flr Classrm (G.SSW2)	80	60.68	450	249	212
Mech 1 (G.WSW3)	2000	1.73	450	249	212
Mech 2 (G.E4)	2000	1.74	450	249	212
Conditioned Mech (G.S8)	2000	2.42	450	249	212
Mech 3 (G.WNW9)	2000	1.04	450	249	212
Blue Planet (T.E10)	80	69.3	450	248	203
Upper Classrms 1 (T.SSW11)	80	60.68	450	248	203
Upper Classrms 2 (T.WSW12)	80	43.31	450	248	203
Corridor1(T.E13)	80	43.38	450	248	203
Office (T.N14)	80	77.96	450	248	203
Corridor 2 (T.W15)	80	26.02	450	248	203
Display 1 (T.N16)	80	17.32	450	248	203
Corridor 3 (T.S17)	80	60.51	450	248	203
Display 2 (T.WNW18)	80	26.02	450	248	203

Table 9 (Cont'd)

Space Name	Lighting (w/ft2)	Lighting Schedule	Lighting Type	Task Light (w/ft2)	Task Lighting Schedule
Ground Flr Classrm (G.SSW2)	1.6	Grnd Flr Ltg Sch	Sus Fluor	0	Grnd Flr Occ Sch
Mech 1 (G.WSW3)	1.6	Grnd Flr Ltg Sch	Sus Fluor	0	Grnd Flr Occ Sch
Mech 2 (G.E4)	1.6	Grnd Flr Ltg Sch	Sus Fluor	0	Grnd Flr Occ Sch
Conditioned Mech (G.S8)	1.6	Grnd Flr Ltg Sch	Sus Fluor	0	Grnd Flr Occ Sch
Mech 3 (G.WNW9)	1.6	Grnd Flr Ltg Sch	Sus Fluor	0	Grnd Flr Occ Sch
Blue Planet (T.E10)	1.6	Top Flr Ltg Sch	Sus Fluor	1	Top Flr Occ Sch
Upper Classrms 1 (T.SSW11)	1.6	Top Flr Ltg Sch	Sus Fluor	0	Top Flr Occ Sch
Upper Classrms 2 (T.WSW12)	1.6	Top Flr Ltg Sch	Sus Fluor	0	Top Flr Occ Sch
Corridor1(T.E13)	1.6	Top Flr Ltg Sch	Sus Fluor	1	Top Flr Occ Sch
Office (T.N14)	1.6	Top Flr Ltg Sch	Sus Fluor	0.15	Top Flr Occ Sch
Corridor 2 (T.W15)	1.6	Top Flr Ltg Sch	Sus Fluor	1	Top Flr Occ Sch
Display 1 (T.N16)	1.6	Top Flr Ltg Sch	Sus Fluor	1	Top Flr Occ Sch
Corridor 3 (T.S17)	1.6	Top Flr Ltg Sch	Sus Fluor	1	Top Flr Occ Sch
Display 2 (T.WNW18)	1.6	Top Flr Ltg Sch	Sus Fluor	1	Top Flr Occ Sch

Table 9 (Cont'd)

Space Name	Equipment Schedule	Equipment (w/ft2)	Infiltration Schedule	A-C Infiltration Flow (cfm/ft2)	Furniture Type	Furniture Weight (lb/ft2)	Furniture Frac
Ground Flr Classrm (G.SSW2)	Grnd Flr Eqp Sch	1.2	Grnd Flr Sys1 Infil Sch	0.005	Heavy	2	0.2
Mech 1 (G.WSW3)	Grnd Flr Eqp Sch	1.2	Grnd Flr Sys1 Infil Sch	0.005	Heavy	2	0.2
Mech 2 (G.E4)	Grnd Flr Eqp Sch	1.2	Grnd Flr Sys1 Infil Sch	0.005	Heavy	2	0.2
Conditioned Mech (G.S8)	Grnd Flr Eqp Sch	1.2	Grnd Flr Sys1 Infil Sch	0.005	Heavy	2	0.2
Mech 3 (G.WNW9)	Grnd Flr Eqp Sch	1.2	Grnd Flr Sys1 Infil Sch	0.005	Heavy	2	0.2
Blue Planet (T.E10)	Top Flr Eqp Sch	1.2	Top Flr Sys1 Infil Sch	0.005	Heavy	2	0.2
Upper Classrms 1 (T.SSW11)	Top Flr Eqp Sch	1.2	Top Flr Sys1 Infil Sch	0.005	Heavy	2	0.2
Upper Classrms 2 (T.WSW12)	Top Flr Eqp Sch	1.2	Top Flr Sys1 Infil Sch	0.005	Heavy	2	0.2
Corridor1(T.E13)	Top Flr Eqp Sch	1.2	Top Flr Sys1 Infil Sch	0.005	Heavy	2	0.2
Office (T.N14)	Top Flr Eqp Sch	1.2	Top Flr Sys1 Infil Sch	0.005	Heavy	2	0.2
Corridor 2 (T.W15)	Top Flr Eqp Sch	1.2	Top Flr Sys1 Infil Sch	0.005	Heavy	2	0.2
Display 1 (T.N16)	Top Flr Eqp Sch	1.2	Top Flr Sys1 Infil Sch	0.005	Heavy	2	0.2
Corridor 3 (T.S17)	Top Flr Eqp Sch	1.2	Top Flr Sys1 Infil Sch	0.005	Heavy	2	0.2
Display 2 (T.WNW18)	Top Flr Eqp Sch	1.2	Top Flr Sys1 Infil Sch	0.005	Heavy	2	0.2

Table 10. Constructions

Construction Name	Specification Method	Absorptance	Roughness	U-Value (Btu/h-ft2-F)	Layers
EWall Construction	Layers Input	0.6	3	0.172	Granite layers
Roof Construction	Layers Input	0.6	1	0.053	Roof Cons Layers
IWall Construction	U-Value Input	0.7	3	2.7	n/a
IFlr Construction	Layers Input	0.7	3	0.813	IFlr Cons Layers
UFCons (G.E1.U2)	Layers Input	0.7	3	0.106	Earth Layers
Earth Wall	Layers Input	0.7	3	0.106	Earth Layers
e roof	U-Value Input	0.7	3	0.067	n/a
Stone Wall	Layers Input	0.7	3	0.172	Granite layers
Sod Roof	Layers Input	0.2	3	0.039	Sod Roof Layers
gwin wall	Layers Input	0.7	3	0.052	Granite & Concrete

Table 11. Layers

Layer Name	Inside Film Resistance (R-Val (h-ft2-F/Btu))	Material 1	Thickness 1 (ft)	Material 2	Thickness 2 (ft)
Roof Cons Layers	0.68	Blt-Up Roof 3/8in (BR01)	0.031	Polyisocyanurate 2in	0.167
IFlr Cons Layers	0.68	Conc HW 140lb 6in (HF-C13)	0.5	Linoleum Tile (LT01)	n/a
Earth Layers	0.68	Light Soil, Damp 12in	1	Underground Wall Ins	n/a
UFLyrs (G.SSW2.U3)	0.68	UFMat (G.SSW2.U3.M1)	n/a	Light Soil, Damp 12in	1
UFLyrs (G.WSW3.U4)	0.68	UFMat (G.WSW3.U4.M1)	n/a	Light Soil, Damp 12in	1
UFLyrs (G.E4.U5)	0.68	UFMat (G.E4.U5.M1)	n/a	Light Soil, Damp 12in	1
UFLyrs (G.N5.U6)	0.68	UFMat (G.N5.U6.M1)	n/a	Light Soil, Damp 12in	1
UFLyrs (G.W6.U7)	0.68	UFMat (G.W6.U7.M1)	n/a	Light Soil, Damp 12in	1
UFLyrs (G.N7.U8)	0.68	UFMat (G.N7.U8.M1)	n/a	Light Soil, Damp 12in	1
UFLyrs (G.S8.U9)	0.68	UFMat (G.S8.U9.M1)	n/a	Light Soil, Damp 12in	1
UFLyrs (G.WNW9.U10)	0.68	UFMat (G.WNW9.U10.M1)	n/a	Light Soil, Damp 12in	1
Granite layers	0.68	Stone Granite	0.33	Wall Ins	n/a
Sod Roof Layers	0.68	Light Soil, Damp 12in	1	2 inch EPI	n/a
Granite & Concrete	0.68	Stone Granite	0.33	2 inch EPI & furring	n/a

Table 11 (Cont'd)

Layer Name	Material 3	Thickness 3 (ft)	Material 4
Roof Cons Layers	Plywd 5/8in (PW04)	0.052	Roof Cons Mat 4 (2.8)
IFlr Cons Layers		n/a	
Earth Layers	Conc HW 140lb 8in (HF-C10)	0.667	Linoleum Tile (LT01)
UFLyrs (G.SSW2.U3)	Conc HW 140lb 8in (HF-C10)	0.667	Linoleum Tile (LT01)
UFLyrs (G.WSW3.U4)	Conc HW 140lb 8in (HF-C10)	0.667	Linoleum Tile (LT01)
UFLyrs (G.E4.U5)	Conc HW 140lb 8in (HF-C10)	0.667	Linoleum Tile (LT01)
UFLyrs (G.N5.U6)	Conc HW 140lb 8in (HF-C10)	0.667	Linoleum Tile (LT01)
UFLyrs (G.W6.U7)	Conc HW 140lb 8in (HF-C10)	0.667	Linoleum Tile (LT01)
UFLyrs (G.N7.U8)	Conc HW 140lb 8in (HF-C10)	0.667	Linoleum Tile (LT01)
UFLyrs (G.S8.U9)	Conc HW 140lb 8in (HF-C10)	0.667	Linoleum Tile (LT01)
UFLyrs (G.WNW9.U10)	Conc HW 140lb 8in (HF-C10)	0.667	Linoleum Tile (LT01)
Granite layers		n/a	
Sod Roof Layers	Roof Cons Mat 4 (2.8)	n/a	
Granite & Concrete	conc2	0.66	

Table 12. Materials

Material Name	Specification Method	Thickness (ft)	Conductivity (btu/h-ft-F)	Density (lb/ft3)	Specific Heat (Btu/lb-F)	Resistance (R-Val (h-ft2-F/Btu))
Roof Cons Mat 4 (2.8)	Resistance	n/a	n/a	n/a	n/a	38.382
UFMat (G.E1.U2.M1)	Resistance	n/a	n/a	n/a	n/a	97.16
UFMat (G.SSW2.U3.M1)	Resistance	n/a	n/a	n/a	n/a	155.25
UFMat (G.WSW3.U4.M1)	Resistance	n/a	n/a	n/a	n/a	38.012
UFMat (G.E4.U5.M1)	Resistance	n/a	n/a	n/a	n/a	24.06
UFMat (G.N5.U6.M1)	Resistance	n/a	n/a	n/a	n/a	16.648
UFMat (G.W6.U7.M1)	Resistance	n/a	n/a	n/a	n/a	28.722
UFMat (G.N7.U8.M1)	Resistance	n/a	n/a	n/a	n/a	56.936
UFMat (G.S8.U9.M1)	Resistance	n/a	n/a	n/a	n/a	6
UFMat (G.WNW9.U10.M1)	Resistance	n/a	n/a	n/a	n/a	n/a
Underground Wall Ins	Resistance	n/a	n/a	n/a	n/a	5
Stone Granite	Properties	0.33	2.5	180		18
Wall Ins	Resistance	n/a	n/a	n/a	n/a	8
2 inch EPI & furring	Resistance	n/a	n/a	n/a	n/a	n/a
4 inch steel stud	Resistance	n/a	n/a	n/a	n/a	20
conc2	Properties	0.66	1.5	140		n/a
2 inch EPI	Resistance	n/a	n/a	n/a	n/a	n/a
Blt-Up Roof 3/8in (BR01)	Properties	0.031	0.0939	70		n/a
Polyisocyanurate 2in	Properties	0.167	0.0117	2		n/a
Plywd 5/8in (PW04)	Properties	0.052	0.0667	34		n/a
Conc HW 140lb 6in (HF-C13)	Properties	0.5	1	140		n/a
Linoleum Tile (LT01)	Resistance	n/a	n/a	n/a	n/a	0.05
Light Soil, Damp 12in	Properties	1	0.5	100		n/a
Conc HW 140lb 8in (HF-C10)	Properties	0.667	1	140		n/a

Table 13. Glass Types

Glass Type Name	Specification Method	Library Selection	Glass Conductance (Btu/h-ft2-F)	Visible Transmittance	Outside Emissivity
ASHRAE 90.1 2470	Glass Library	2470	1.47	0.9	0.84
AFG Gwinnett GT	Glass Library	AFG Gwinnett	1.47	0.9	0.84
Glass Type 3	Glass Library	4651	1.47	0.9	0.84

Table 14. Glass Type Codes

GTC Name	Description	Layers	Shading Coefficient	U-Value (Center)	Solar Reflectance	Visible Reflectance
Bronze Double A	Bronze Double A	2	0.53	2.68	0.117	0.124
Clear Double Al	Clear Double Al	2	0.76	2.68	0.184	0.229
TC88 Clear	TC88 Clear	3	0.47	0.81	0.273	0.222
SC75 Clear	SC75 Clear	3	0.34	0.98	0.519	0.352
HMTC88 AZlte	HMTC88 AZlte	3	0.36	0.82	0.164	0.195
HMSC75 AZlte	HMSC75 AZlte	3	0.29	0.99	0.264	0.294
Clear Double Wo	Clear Double Wo	2	0.67	2.53	0.184	0.229
VE 12M Double,	VE 12M Double,	2	0.38	1.64	0.337	0.197
VE 22M Double,	VE 22M Double,	2	0.32	1.64	0.332	0.191
HM77 Gray Doubl	HM77 Gray Doubl	3	0.35	1.25	0.242	0.179
HM88 Double, Wo	HM88 Double, Wo	3	0.58	1.31	0.313	0.284
PPG Azlte Doubl	PPG Azlte Doubl	2	0.39	2.64	0.174	0.219
PPG SolBan Doub	PPG SolBan Doub	2	0.39	1.65	0.33	0.204
AFG Gwinnett	AFG Gwinnett	2	0.41	1.72	0.243	0.182
2470	Dbl Ref-D Tint 6mm/6mm Air	2	0.41	3.15	0.326	0.475
4651	Quadruple Low-E Films Clear 3mm/8mm Krypton	4	0.52	0.66	0.389	0.307

Table 14 (Cont'd)

GTC Name	Film Cond. 1	Film Cond. 2	Film Cond. 3	ID1	ID2	ID3	ID4	Width 1	Width 2	Width 3	Width 4
Bronze Double A				101	101	0	0	5.7	5.7	0	0
Clear Double Al				103	103	0	0	5.7	5.7	0	0
TC88 Clear				103	1511	103	0	5.7	0.1	5.7	0
SC75 Clear				103	1510	103	0	5.7	0.1	5.7	0
HMTC88 AZlte				5032	1511	5032	0	2.3	0.1	2.3	0
HMSC75 AZlte				5032	1510	5032	0	2.3	0.1	2.3	0
Clear Double Wo				103	103	0	0	5.7	5.7	0	0
VE 12M Double,				6046	103	0	0	5.7	5.7	0	0
VE 22M Double,				6051	103	0	0	5.7	5.7	0	0
HM77 Gray Doubl				104	1505	104	0	3.1	0.1	3.1	0
HM88 Double, Wo				102	1506	102	0	3	0.1	3	0
PPG Azlte Doubl				5036	5012	0	0	5.7	5.7	0	0
PPG SolBan Doub				5284	103	0	0	5.7	5.7	0	0
AFG Gwinnett				783	103	0	0	5.6	5.7	0	0
2470	25.47	3.25	7.99	270	3	0	0	6	6	0	0
4651	25.47	3.19	7.2	2	600	600	2	3	0.1	0.1	3

Table 14 (Cont'd)

GTC Name	Front Emissivity 1	Front Emissivity 2	Front Emissivity 3	Front Emissivity 4	Back Emissivity 1	Back Emissivity 2	Back Emissivity 3	Back Emissivity 4
Bronze Double A	0.84	0.84	0	0	0.84	0.84	0	0
Clear Double Al	0.84	0.84	0	0	0.84	0.84	0	0
TC88 Clear	0.84	0.127	0.84	0	0.84	0.109	0.84	0
SC75 Clear	0.84	0.755	0.84	0	0.84	0.055	0.84	0
HMTC88 AZlte	0.84	0.127	0.84	0	0.84	0.109	0.84	0
HMSC75 AZlte	0.84	0.755	0.84	0	0.84	0.055	0.84	0
Clear Double Wo	0.84	0.84	0	0	0.84	0.84	0	0
VE 12M Double,	0.84	0.84	0	0	0.04	0.84	0	0
VE 22M Double,	0.84	0.84	0	0	0.04	0.84	0	0
HM77 Gray Doubl	0.84	0.07	0.84	0	0.84	0.755	0.84	0
HM88 Double, Wo	0.84	0.122	0.84	0	0.84	0.755	0.84	0
PPG Azlte Doubl	0.84	0.84	0	0	0.84	0.84	0	0
PPG SolBan Doub	0.84	0.84	0	0	0.043	0.84	0	0
AFG Gwinnett	0.84	0.84	0	0	0.079	0.84	0	0
2470	0.84	0.84	0	0	0.82	0.84	0	0
4651	0.84	0.136	0.136	0.84	0.84	0.72	0.72	0.84

Table 14 (Cont'd)

GTC Name	Conductance 1	Conductance 2	Conductance 3	Conductance 4	Gas 1	Gas 2	Gas 3	Gas 4
Bronze Double A	174.2	174.2	0	0	Air	Air	Air	Air
Clear Double Al	175	175	0	0	Air	Air	Air	Air
TC88 Clear	175	1839.7	175	0	Argon	Argon	Air	Air
SC75 Clear	175	1839.7	175	0	Argon	Argon	Air	Air
HMTC88 AZlte	442.4	1839.7	442.4	0	Argon	Argon	Air	Air
HMSC75 AZlte	442.4	1839.7	442.4	0	Argon	Argon	Air	Air
Clear Double Wo	175	175	0	0	Argon	Air	Air	Air
VE 12M Double,	176.7	175	0	0	Air	Air	Air	Air
VE 22M Double,	176.7	175	0	0	Air	Air	Air	Air
HM77 Gray Doubl	320.1	1839.7	320.1	0	Air	Air	Air	Air
HM88 Double, Wo	328.1	1839.7	328.1	0	Air	Air	Air	Air
PPG Azlte Doubl	176.5	176.5	0	0	Air	Air	Air	Air
PPG SolBan Doub	176.5	175	0	0	Air	Air	Air	Air
AFG Gwinnett	178.1	175	0	0	Air	Air	Air	Air
2470	150	150	0	0	Air	Air	Air	Air
4651	300	2755.9	2755.9	300	Krypton	Krypton	Krypton	Air

Table 14 (Cont'd)

GTC Name	Width 1	Width 2	Width 3	Condu-ctivity 1	Condu-ctivity 2	Conduc-tivity 3	dConduc-tivity 1	dConduc-tivity 2	dConduc-tivity 3
Bronze Double A	12.7	0	0	0.024	0	0	7.76	0	0
Clear Double Al	12.7	0	0	0.024	0	0	7.76	0	0
TC88 Clear	12.7	12.7	0	0.016	0.016	0	5.149	5.149	0
SC75 Clear	12.7	12.7	0	0.016	0.016	0	5.149	5.149	0
HMTC88 AZlte	12.7	12.7	0	0.016	0.016	0	5.149	5.149	0
HMSC75 AZlte	12.7	12.7	0	0.016	0.016	0	5.149	5.149	0
Clear Double Wo	12.7	0	0	0.016	0	0	5.149	0	0
VE 12M Double,	12.7	0	0	0.024	0	0	7.76	0	0
VE 22M Double,	12.7	0	0	0.024	0	0	7.76	0	0
HM77 Gray Doubl	12.7	12.7	0	0.024	0.024	0	7.76	7.76	0
HM88 Double, Wo	12.7	12.7	0	0.024	0.024	0	7.76	7.76	0
PPG Azlte Doubl	12.7	0	0	0.024	0	0	7.76	0	0
PPG SolBan Doub	12.7	0	0	0.024	0	0	7.76	0	0
AFG Gwinnett	12.7	0	0	0.024	0	0	7.76	0	0
2470	6.3	0	0	0.024	0	0	7.6	0	0
4651	7.9	3.2	7.9	0.009	0.009	0.009	2.8	2.8	2.8

Table 14 (Cont'd)

GTC Name	Viscosity 1	Viscosity 2	Viscosity 3	dViscosity 1	dViscosity 2	dViscosity 3
Bronze Double A	1.722	0	0	4.94	0	0
Clear Double Al	1.722	0	0	4.94	0	0
TC88 Clear	2.1	2.1	0	6.451	6.451	0
SC75 Clear	2.1	2.1	0	6.451	6.451	0
HMTC88 AZlte	2.1	2.1	0	6.451	6.451	0
HMSC75 AZlte	2.1	2.1	0	6.451	6.451	0
Clear Double Wo	2.1	0	0	6.451	0	0
VE 12M Double,	1.722	0	0	4.94	0	0
VE 22M Double,	1.722	0	0	4.94	0	0
HM77 Gray Doubl	1.722	1.722	0	4.94	4.94	0
HM88 Double, Wo	1.722	1.722	0	4.94	4.94	0
PPG Azlte Doubl	1.722	0	0	4.94	0	0
PPG SolBan Doub	1.722	0	0	4.94	0	0
AFG Gwinnett	1.722	0	0	4.94	0	0
2470	1.73	0	0	10	0	0
4651	2.28	2.28	2.28	7.5	7.5	7.5

Table 14(Cont'd)

GTC Name	**Density 1**	**Density 2**	**Density 3**	**dDensity 1**	**dDensity 2**	**dDensity 3**
Bronze Double A	1.292	0	0	-0.005	0	0
Clear Double Al	1.292	0	0	-0.005	0	0
TC88 Clear	1.782	1.782	0	-0.006	-0.006	0
SC75 Clear	1.782	1.782	0	-0.006	-0.006	0
HMTC88 AZlte	1.782	1.782	0	-0.006	-0.006	0
HMSC75 AZlte	1.782	1.782	0	-0.006	-0.006	0
Clear Double Wo	1.782	0	0	-0.006	0	0
VE 12M Double,	1.292	0	0	-0.005	0	0
VE 22M Double,	1.292	0	0	-0.005	0	0
HM77 Gray Doubl	1.292	1.292	0	-0.005	-0.005	0
HM88 Double, Wo	1.292	1.292	0	-0.005	-0.005	0
PPG Azlte Doubl	1.292	0	0	-0.005	0	0
PPG SolBan Doub	1.292	0	0	-0.005	0	0
AFG Gwinnett	1.292	0	0	-0.005	0	0
2470	1.29	0	0	-0.004	0	0
4651	3.74	3.74	3.74	-0.014	-0.014	-0.014

Table 14 (Cont'd)

GTC Name	Prandtl Num 1	Prandtl Num 2	Prandtl Num 3	dPrandtl Num 1	dPrandtl Num 2	dPrandtl Num 3
Bronze Double A	0.72	0	0	0	0	0
Clear Double Al	0.72	0	0	0	0	0
TC88 Clear	0.67	0.67	0	0	0	0
SC75 Clear	0.67	0.67	0	0	0	0
HMTC88 AZlte	0.67	0.67	0	0	0	0
HMSC75 AZlte	0.67	0.67	0	0	0	0
Clear Double Wo	0.67	0	0	0	0	0
VE 12M Double,	0.72	0	0	0	0	0
VE 22M Double,	0.72	0	0	0	0	0
HM77 Gray Doubl	0.72	0.72	0	0	0	0
HM88 Double, Wo	0.72	0.72	0	0	0	0
PPG Azlte Doubl	0.72	0	0	0	0	0
PPG SolBan Doub	0.72	0	0	0	0	0
AFG Gwinnett	0.72	0	0	0	0	0
2470	0.72	0	0	0.002	0	0
4651	0.66	0.66	0.66	0	0	0

Table 14 (Cont'd)

GTC Name	Solar Trans 0	Solar Trans 10	Solar Trans 20	Solar Trans 30	Solar Trans 40	Solar Trans 50	Solar Trans 60	Solar Trans 70	Solar Trans 80	Solar Trans 90	Solar Trans hemi
Bronze Double A	0.24	0.24	0.24	0.23	0.21	0.19	0.16	0.11	0.04	0	0.18
Clear Double Al	0.61	0.61	0.6	0.59	0.58	0.55	0.48	0.36	0.17	0	0.51
TC88 Clear	0.35	0.35	0.34	0.33	0.32	0.3	0.24	0.16	0.06	0	0.27
SC75 Clear	0.28	0.17	0.17	0.17	0.17	0.16	0.14	0.1	0.04	0	0.14
HMTC88 AZlte	0.23	0.23	0.22	0.22	0.2	0.19	0.15	0.1	0.03	0	0.17
HMSC75 AZlte	0.2	0.15	0.15	0.15	0.15	0.14	0.12	0.08	0.03	0	0.13
Clear Double Wo	0.61	0.61	0.6	0.59	0.58	0.55	0.48	0.36	0.17	0	0.51
VE 12M Double,	0.33	0.33	0.32	0.32	0.31	0.29	0.25	0.18	0.08	0	0.27
VE 22M Double,	0.24	0.24	0.24	0.23	0.23	0.22	0.19	0.14	0.06	0	0.2
HM77 Gray Doubl	0.19	0.19	0.19	0.18	0.17	0.15	0.12	0.07	0.02	0	0.14
HM88 Double, Wo	0.48	0.48	0.48	0.47	0.46	0.43	0.37	0.26	0.11	0	0.4
PPG Azlte Doubl	0.28	0.27	0.27	0.26	0.25	0.23	0.2	0.15	0.07	0	0.22
PPG SolBan Doub	0.33	0.33	0.32	0.32	0.31	0.29	0.25	0.18	0.08	0	0.27
AFG Gwinnett	0.28	0.29	0.28	0.28	0.27	0.25	0.22	0.16	0.07	0	0.23
2470	0.24	0.24	0.24	0.23	0.22	0.21	0.18	0.14	0.06	0	0.2
4651	0.34	0.34	0.33	0.32	0.31	0.29	0.24	0.16	0.06	0	0.27

Table 14 (Cont'd)

GTC Name	Visible Trans 0	Visible Trans 10	Visible Trans 20	Visible Trans 30	Visible Trans 40	Visible Trans 50	Visible Trans 60	Visible Trans 70	Visible Trans 80	Visible Trans 90	Visible Trans hemi
Bronze Double A	0.29	0.28	0.28	0.27	0.25	0.23	0.19	0.13	0.05	0	0.22
Clear Double Al	0.79	0.79	0.78	0.78	0.77	0.74	0.66	0.51	0.25	0	0.68
TC88 Clear	0.63	0.63	0.62	0.61	0.59	0.55	0.45	0.3	0.11	0	0.5
SC75 Clear	0.6	0.55	0.55	0.55	0.53	0.5	0.44	0.31	0.13	0	0.46
HMTC88 AZlte	0.53	0.54	0.52	0.51	0.49	0.45	0.37	0.23	0.08	0	0.42
HMSC75 AZlte	0.51	0.48	0.47	0.47	0.45	0.42	0.36	0.25	0.09	0	0.39
Clear Double Wo	0.79	0.79	0.78	0.78	0.77	0.74	0.66	0.51	0.25	0	0.68
VE 12M Double,	0.7	0.71	0.7	0.68	0.67	0.63	0.55	0.4	0.18	0	0.58
VE 22M Double,	0.6	0.61	0.6	0.59	0.57	0.54	0.47	0.34	0.16	0	0.5
HM77 Gray Doubl	0.31	0.31	0.3	0.28	0.27	0.24	0.19	0.11	0.03	0	0.22
HM88 Double, Wo	0.72	0.72	0.72	0.71	0.7	0.66	0.57	0.4	0.17	0	0.6
PPG Azlte Doubl	0.61	0.61	0.6	0.6	0.58	0.55	0.49	0.36	0.17	0	0.51
PPG SolBan Doub	0.69	0.69	0.68	0.67	0.65	0.62	0.54	0.39	0.18	0	0.57
AFG Gwinnett	0.46	0.46	0.45	0.44	0.43	0.41	0.36	0.26	0.12	0	0.38
2470	0.23	0.23	0.23	0.22	0.22	0.21	0.18	0.14	0.07	0	0.19
4651	0.62	0.62	0.62	0.61	0.59	0.55	0.45	0.29	0.1	0	0.5

Table 14 (Cont'd)

GTC Name	Sol Abs1 0	Sol Abs1 10	Sol Abs1 20	Sol Abs1 30	Sol Abs1 40	Sol Abs1 50	Sol Abs1 60	Sol Abs1 70	Sol Abs1 80	Sol Abs1 90	Sol Abs1 hemi
Bronze Double A	0.47	0.47	0.48	0.49	0.5	0.52	0.53	0.52	0.44	0	0.5
Clear Double Al	0.17	0.17	0.17	0.17	0.18	0.19	0.2	0.21	0.2	0	0.19
TC88 Clear	0.2	0.2	0.2	0.21	0.22	0.23	0.23	0.24	0.22	0	0.22
SC75 Clear	0.23	0.27	0.28	0.28	0.29	0.3	0.31	0.3	0.26	0	0.29
HMTC88 AZlte	0.46	0.46	0.47	0.47	0.48	0.49	0.49	0.47	0.39	0	0.47
HMSC75 AZlte	0.5	0.56	0.56	0.57	0.58	0.58	0.57	0.54	0.43	0	0.56
Clear Double Wo	0.17	0.17	0.17	0.17	0.18	0.19	0.2	0.21	0.2	0	0.19
VE 12M Double,	0.34	0.34	0.35	0.35	0.35	0.35	0.36	0.36	0.28	0	0.34
VE 22M Double,	0.64	0.64	0.65	0.65	0.64	0.64	0.63	0.59	0.44	0	0.62
HM77 Gray Doubl	0.42	0.42	0.43	0.44	0.45	0.46	0.47	0.46	0.4	0	0.44
HM88 Double, Wo	0.12	0.12	0.12	0.12	0.13	0.13	0.14	0.15	0.14	0	0.13
PPG Azlte Doubl	0.64	0.64	0.64	0.65	0.65	0.66	0.65	0.61	0.48	0	0.63
PPG SolBan Doub	0.37	0.37	0.38	0.38	0.38	0.38	0.39	0.38	0.3	0	0.37
AFG Gwinnett	0.57	0.58	0.58	0.58	0.58	0.58	0.58	0.55	0.42	0	0.56
2470	0.57	0.57	0.58	0.58	0.58	0.57	0.57	0.54	0.4	0	0.55
4651	0.12	0.12	0.12	0.12	0.13	0.13	0.14	0.15	0.15	0	0.13

Table 14 (Cont'd)

GTC Name	Sol Abs2 0	Sol Abs2 10	Sol Abs2 20	Sol Abs2 30	Sol Abs2 40	Sol Abs2 50	Sol Abs2 60	Sol Abs2 70	Sol Abs2 80	Sol Abs2 90	Sol Abs2 hemi
Bronze Double A	0.22	0.22	0.22	0.22	0.21	0.21	0.19	0.16	0.09	0	0.19
Clear Double Al	0.11	0.11	0.12	0.12	0.12	0.12	0.12	0.1	0.07	0	0.11
TC88 Clear	0.18	0.19	0.19	0.19	0.19	0.19	0.2	0.19	0.13	0	0.19
SC75 Clear	0.13	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0	0.03
HMTC88 AZlte	0.12	0.12	0.13	0.13	0.13	0.13	0.13	0.12	0.08	0	0.12
HMSC75 AZlte	0.09	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0	0.03
Clear Double Wo	0.11	0.11	0.12	0.12	0.12	0.12	0.12	0.1	0.07	0	0.11
VE 12M Double,	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0	0.03
VE 22M Double,	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0	0.02
HM77 Gray Doubl	0.07	0.07	0.07	0.08	0.08	0.08	0.08	0.08	0.06	0	0.08
HM88 Double, Wo	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.09	0.07	0	0.1
PPG Azlte Doubl	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0	0.02
PPG SolBan Doub	0.03	0.03	0.03	0.04	0.04	0.04	0.03	0.03	0.02	0	0.03
AFG Gwinnett	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.04	0.03	0	0.04
2470	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.04	0.03	0	0.05
4651	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.07	0	0.1

Table 14 (Cont'd)

GTC Name	Sol Abs3 0	Sol Abs3 10	Sol Abs3 20	Sol Abs3 30	Sol Abs3 40	Sol Abs3 50	Sol Abs3 60	Sol Abs3 70	Sol Abs3 80	Sol Abs3 90	Sol Abs3 hemi
Bronze Double A	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Clear Double Al	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
TC88 Clear	0.05	0.05	0.05	0.05	0.05	0.05	0.04	0.03	0.02	0	0.04
SC75 Clear	0.03	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0	0	0.01
HMTC88 AZlte	0.08	0.08	0.07	0.07	0.07	0.07	0.06	0.04	0.02	0	0.06
HMSC75 AZlte	0.05	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0	0.02
Clear Double Wo	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
VE 12M Double,	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
VE 22M Double,	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
HM77 Gray Doubl	0.1	0.1	0.1	0.1	0.1	0.09	0.08	0.06	0.03	0	0.09
HM88 Double, Wo	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.02	0	0.04
PPG Azlte Doubl	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
PPG SolBan Doub	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
AFG Gwinnett	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2470	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4651	0.07	0.07	0.08	0.08	0.07	0.07	0.07	0.06	0.04	0	0.07

Table 14 (Cont'd)

GTC Name	Sol Abs40	Sol Abs410	Sol Abs420	Sol Abs430	Sol Abs440	Sol Abs450	Sol Abs460	Sol Abs470	Sol Abs480	Sol Abs490	Sol Abs4hemi
Bronze Double A	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Clear Double Al	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
TC88 Clear	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
SC75 Clear	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
HMTC88 AZlte	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
HMSC75 AZlte	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Clear Double Wo	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
VE 12M Double,	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
VE 22M Double,	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
HM77 Gray Doubl	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
HM88 Double, Wo	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
PPG Azlte Doubl	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
PPG SolBan Doub	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
AFG Gwinnett	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2470	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4651	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.02	0	0.03

Water-side HVAC

Table 15. Circulation Loops

Circulation Loop name	Loop Type	Loop Subtype	Sizing Option	Loop Pump
Chilled Water Loop	Chilled Water	Primary	Secondary	CHW Loop Pump
Condenser Water Loop	Condenser Water	Primary	Secondary	CW Loop Pump
Domestic Hot Water Loop	Domestic Hot Water	Primary	Secondary	- undefined -

Table 15 (Cont'd)

Circulation Loop name	Design CHW Temp	Design HW Temp	Loop Design (Delta)	Avg Circ Time	Loop Minimum Flow	Loop Size	Assign Losses To
		F			Ratio		
Chilled Water Loop	44		10	1.5	0.05	1	Space Heat/Cool
Condenser Water Loop	85		10	1.5	0.05	1	n/a
Domestic Hot Water Loop		135	80	1.5		1	Dom Hot Water

Table 15 (Cont'd)

Circulation Loop name	**Head Setpoint Control**	**Head Sensor Location**	**Head Setpoint Range**	**Head Setpoint**	**Loop Operation**	**Loop Setpoin-t Range**	**Heat Setpoin-t Control**	**Heat Setpoint Temperature**
			ft	**Ratio**		**delta F**		**F**
Chilled Water Loop	Fixed	Entering Loop	2	1	Standby	2	n/a	n/a
Condenser Water Loop	Fixed	Entering Loop	2	1	Demand	2	n/a	n/a
Domestic Hot Water Loop	n/a	n/a	n/a	n/a	n/a	n/a	Fixed	135

Table 15 (Cont'd)

Circulation Loop name	**Cool Setpoint Control**	**Cool Setpoint Temperature**	**Max Reset Temp**	**Min Reset Temp**	**Min Alarm Temp**	**Process Flow**	**Process load 1 Schedule**
			F			**gpm**	
Chilled Water Loop	Fixed	44	65	40	n/a	n/a	n/a
Condenser Water Loop	Fixed	85	95	70	n/a	n/a	n/a
Domestic Hot Water Loop	n/a	n/a	n/a	n/a	110	3.5	Grnd Flr Occ Sch

Table 16. Pumps

Pump Name	Pum-p Head Ratio	Pum-p Flow Ratio	Pump Number	Mech Efficiency Ratio	Motor Class	Capacity Ctrl	Pump Head f(flow)	Pump Power f(flow)	Max Pump Ratio	Pump Power Exponent Ratio	Electric Meter
CHW Loop Pump	1.2	1	1	0.77	High Effici-ency	One Speed Pump	Pump-Head-fFlow	Pump-Power-fFlow	1.3	3.05	EM1
CW Loop Pump	1.2	1	1	0.77	Standard	One Speed Pump	Pump-Head-fFlow	Pump-Power-fFlow	1.3	3.05	EM2

Table 17. Chiller

Chiller Name	Chiller Type	Chilled Water Loop	Cond-enser Water Loop	Min Ratio	Elec-Input Ratio	Compres-sors/Ckt	Design Chille-d Water Temp	Design Conde-nser Temp	Rated Chille-d Water Temp	Rated Conde-nser Temp	Rated Cond-enser Flow
							F				gpm/ton
Chiller1 (ElecCentHerm)	Electric Screw	Chilled Water Loop	Conde-nser Water Loop	0.1	0.2528	One	44	85	44	85	3

Table 17 (Cont'd)

Chiller Name	Conde-nser Type	Elec to Conde-nser Ratio	Minimu-m Cond Temp	Elec Input Ratio f	Elec Input Ratio f	Cooling Capacity f	Chille-d Water Delta T	Chille-d Water Head
			F	(t evap leaving, t cond entering)	part load ratio	(t evap leaving, t cond entering)	F	ft
Chiller1 (ElecCentHerm)	Water Cooled	1	70	ScrewH2O-EIR-fCHWT&ECT	ScrewH2O-EIR-fPLR&dT-1Comp/Ckt	ScrewH2O-Cap-fCHWT&ECT	10	15

Table 17 (Cont'd)

Chiller Name	Chilled Water Maximum Flow	Condenser Water Flow Control	Condenser Water Delta T	Condenser Water Head	Startup Time	Standby Time
	Ratio		F	ft	h	
Chiller1 (ElecCentHerm)	1.4	Constant Flow	10	15	0.04	0.025

Table 18. Heat Rejection Tower

Heat Rejection Name	Heat Reject-ion Type	Conden-ser Water Loop	Design Wet bulb	Design Appr-oach	Design Range	Elec Input Ratio	Cell Control	Cell Max Flow	Cell Min Flow	Cap Control	Fan Off Flow
			F	F (Delta)				Ratio			Ratio
Open Tower	Open Tower	Condenser Water Loop	78	7	10	0.0105	Minimum Cells	2	0.33	One-Speed Fan	0.1

Table 18 (Cont'd)

Heat Rejection Name	Capacity f	Capacity f	Capacity f	Max Range	Recirc Loop CW Delta	Recirc Loop CW Head	Recirc Loop CW Static Head
	(approach, wetbulb)	(range, wetbulb)	(twr airflow)	F (Delta)		ft	
Open Tower	OpenTwr-FluidCap-fApp&WB	OpenTwr-FluidCap-fRng&WB	OpenTwr-FluidCap-fAirflow	40	10	10	10

Table 19. Performance Curves

Curve Fit Name	Curve Fit Type	Input Type	Minimum Output	Maximum Output
Pump-Head-fFlow	Quadratic	Curve Coefficients	-1000000	1000000
Pump-Power-fFlow	Quadratic	Curve Coefficients	-1000000	1000000
OpenTwr-FluidCap-fAirflow	Quadratic	Curve Coefficients	-1000000	1000000
ForCurve w Dischrg Dampers FPLR	Quadratic	Curve Coefficients	0.22	1
Large-CHW-Bypass-fAirFlow	Quadratic	Curve Coefficients	-1000000	1000000
CHW-Coil-Cap-fAirFlow	Quadratic	Curve Coefficients	-1000000	1000000
CHW-Coil-Cap-fFluidFlow	Quadratic	Curve Coefficients	-1000000	1000000
ScrewH2O-Cap-fCHWT&ECT	Bi-Quadratic in T	Curve Coefficients	-1000000	1000000
ScrewH2O-EIR-fCHWT&ECT	Bi-Quadratic in T	Curve Coefficients	-1000000	1000000
Large-CHW-Coil-Cap-fEWB&EDB	Bi-Quadratic in T	Curve Coefficients	-1000000	1000000
Large-CHW-Sens-Cap-fEWB&EDB	Bi-Quadratic in T	Curve Coefficients	-1000000	1000000
Large-CHW-Coil-Bypass-fEWB&EDB	Bi-Quadratic in T	Curve Coefficients	-1000000	1000000
CHW-Coil-Cap-fEWB&EWT	Bi-Quadratic in T	Curve Coefficients	-1000000	1000000
OpenTwr-FluidCap-fApp&WB	Bi-Quadratic in dT&T	Curve Coefficients	-1000000	1000000
OpenTwr-FluidCap-fRng&WB	Bi-Quadratic in dT&T	Curve Coefficients	-1000000	1000000
DW-Elec-EIR-fPLR	Linear	Curve Coefficients	-1000000	1000000
Coil-Bypass-Factor-fPLR	Linear	Curve Coefficients	-1000000	1000000

Table 19 (Cont'd)

Curve Fit Name	**Coefficie-nt 1**	**Coefficie-nt 2**	**Coefficie-nt 3**	**Coeffici-ent 4**	**Coeffici-ent 5**	**Coeffici-ent 6**
Pump-Head-fFlow	1.353483	0.01593	-0.369414	n/a	n/a	n/a
Pump-Power-fFlow	0.369774	0.84038	-0.210149	n/a	n/a	n/a
OpenTwr-FluidCap-fAirflow	0.049768	1.0467	-0.096468	n/a	n/a	n/a
ForCurve w Dischrg Dampers FPLR	0.190667	0.31	0.5	n/a	n/a	n/a
Large-CHW-Bypass-fAirFlow	0.396606	0.14965	0.453747	n/a	n/a	n/a
CHW-Coil-Cap-fAirFlow	0.048809	1.37642	-0.425232	n/a	n/a	n/a
CHW-Coil-Cap-fFluidFlow	0.218387	1.51145	-0.729841	n/a	n/a	n/a
ScrewH2O-Cap-fCHWT&ECT	0.898231	0.00045	0.000237	-0.00105	-3E-05	-2E-05
ScrewH2O-EIR-fCHWT&ECT	0.624936	-0.001	0.000174	-0.00086	0.0002	-0.0003
Large-CHW-Coil-Cap-fEWB&EDB	2.588259	-0.2306	0.003836	0.102581	0.0006	-0.0029
Large-CHW-Sens-Cap-fEWB&EDB	0.898277	-0.1312	0.001969	0.089664	0.0006	-0.002
Large-CHW-Coil-Bypass-fEWB&EDB	-2.26258	0.2171	-0.001474	-0.10559	0.0004	0.0003
CHW-Coil-Cap-fEWB&EWT	3.598108	-0.1445	0.002011	0.077641	3E-05	-0.0018
OpenTwr-FluidCap-fApp&WB	0.500614	0.00588	0.000216	-0.01913	0.0002	0.0011
OpenTwr-FluidCap-fRng&WB	0.083524	0.11247	-0.001358	3.42E-05	3E-05	-0.0003
DW-Elec-EIR-fPLR	0	1	n/a	n/a	n/a	n/a
Coil-Bypass-Factor-fPLR	1	0	n/a	n/a	n/a	n/a

Air-side HVAC and Meters

Table 20. Air-Side HVAC

HVAC System Name	HVAC System Type	Dual Duct Type	CHW Loop	Supply cfm	Return Path	Return cfm	Sizing	Sizing Option
							Ratio	
Sys1 (VAVS) (G)	Multi-Zone	Single Fan	Chilled Water Loop	45281	Duct	18200	1.25	Non Coincident
Sys1 (VAVS) (T)	Multi-Zone	Single Fan	Chilled Water Loop	45281	Duct	18200	1.25	Non Coincident

Table 20 (Cont'd)

HVAC System Name	Min Supply T	Max Supply T	Max Humidity	Min Humidity	Duct Air Loss OA	Cooling Fan Schedule	Cooling Fan Control	Return Fan Control	Return Fan Placement
	F				Ratio				
Sys1 (VAVS) (G)	55	105	90	0	1	Sys1 (VAVS) Fan Sch	Fan EIR FPLR	Fan EIR FPLR	Common
Sys1 (VAVS) (T)	55	105	90	0	1	Sys1 (VAVS) Fan Sch	Fan EIR FPLR	Fan EIR FPLR	Common

Table 20 (Cont'd)

HVAC System Name	Cooling Fan Placement	Cooling Motor Placement	Cooling Static	Return Static	Cooling Tot Eff Frac	Cooling Mech Eff Frac	Return Tot Eff Frac	Cooling Fan EIR f	Return Fan EIR f
			in. water			Ratio		PLR	
Sys1 (VAVS) (G)	Blow Through	In Airflow	3.5	1.17	0.63	0.55	0.63	ForCurve w Dischrg Dampers FPLR	ForCurve w Dischrg Dampers FPLR
Sys1 (VAVS) (T)	Blow Through	In Airflow	3.5	1.17	0.63	0.55	0.63	ForCurve w Dischrg Dampers FPLR	ForCurve w Dischrg Dampers FPLR

Table 20 (Cont'd)

HVAC System Name	Cooling Design Flow	Return Design Flow	Cooling Min Flow	Heating Min Flow	Cooling Max Flow	Cooling Min Fan
	cfm		Ratio			
Sys1 (VAVS) (G)	45281	18200	0.01	0.01	1.1	0.3
Sys1 (VAVS) (T)	45281	18200	0.01	0.01	1.1	0.3

Table 20 (Cont'd)

HVAC System Name	Overall Min Flow	Min Flow Source	Night Cycle Control	Minimum OA Method	OA Sizing Method	Outside Air Control	Drybulb High Limit	Maximum OA Fraction	Cool Sizing
	Ratio						F	Ratio	
Sys1 (VAVS) (G)	1	Cold Duct	Stay Off	Fraction of Design Flow	Sum of Zone OA	OA Temperature	65	1	1
Sys1 (VAVS) (T)	1	Cold Duct	Stay Off	Fraction of Design Flow	Sum of Zone OA	OA Temperature	65	1	1

Table 20 (Cont'd)

HVAC System Name	CHW Loop	CHW Coil Head	CHW Coil Delta T	CHW Valve Type	Coil Design Bypass Factor	Min Bypass Extrapolation Temp	Zone Entering Min Supply Temp	Cool Control Range	Maximum Humidity	Cool Control
		ft	F (Delta)		Ratio	F		R	%	
Sys1 (VAVS) (G)	Chilled Water Loop	15	10	Three Way	0.078	70	55	4	90	Constant
Sys1 (VAVS) (T)	Chilled Water Loop	15	10	Three Way	0.078	70	55	4	90	Constant

Table 20 (Cont'd)

HVAC System Name	Total Capacity f	Sensible Capacity f	Bypass Factor f	Total Capacity f	Total Capacity f	Total Capacity f
	t entering wb, t cond entering			t entering wb, t entering water	Supply Air Flow	CHW Flow
Sys1 (VAVS) (G)	Large-CHW-Coil-Cap-fEWB&EDB	Large-CHW-Sens-Cap-fEWB&EDB	Large-CHW-Coil-Bypass-fEWB&EDB	CHW-Coil-Cap-fEWB&EWT	CHW-Coil-Cap-fAirFlow	CHW-Coil-Cap-fFluidFlow
Sys1 (VAVS) (T)	Large-CHW-Coil-Cap-fEWB&EDB	Large-CHW-Sens-Cap-fEWB&EDB	Large-CHW-Coil-Bypass-fEWB&EDB	CHW-Coil-Cap-fEWB&EWT	CHW-Coil-Cap-fAirFlow	CHW-Coil-Cap-fFluidFlow

Table 20 (Cont'd)

HVAC System Name	Bypass Factor f	Bypass Factor f	Heat Source	Heat Sizing	Zone Entering Max Supply Temp
	Supply Air Flow	Cycling		Ratio	F
Sys1 (VAVS) (G)	Large-CHW-Bypass-fAirFlow	Coil-Bypass-Factor-fPLR	Electric	1.2	105
Sys1 (VAVS) (T)	Large-CHW-Bypass-fAirFlow	Coil-Bypass-Factor-fPLR	Electric	1.2	105

Table 20 (Cont'd)

HVAC System Name	Minimum Humidity	Availability Schedule	Heat Control	Preheat Leaving Temperature	Preheat Source
	%			F	
Sys1 (VAVS) (G)	0	Grnd Flr Sys1 Heat Sch	Constant	45	Electric
Sys1 (VAVS) (T)	0	Grnd Flr Sys1 Heat Sch	Constant	45	Electric

Table 21. Electric Meter

Electric Meter Name	Electric Meter Type	Source-to-Site Efficiency	Energy Billing Unit Label	Demand Billing Unit Label
		Btu/Btu		
EM1	Utility	0.33	54	28

Table 22. Fuel Meter

Fuel Meter Name	Fuel Meter Type	Source-to-Site Efficiency	Energy Billing Unit Label	Demand Billing Unit Label	Billing Unit Thermal Value
		Btu/Btu			Btu/Unit
EM1	Natural Gas	1	88	89	100000

APPENDIX B

DETAILS OF THE RESULTS OF THE PARAMETRIC RUNS OF THE ORIGINAL EQUEST ENERGY MODEL

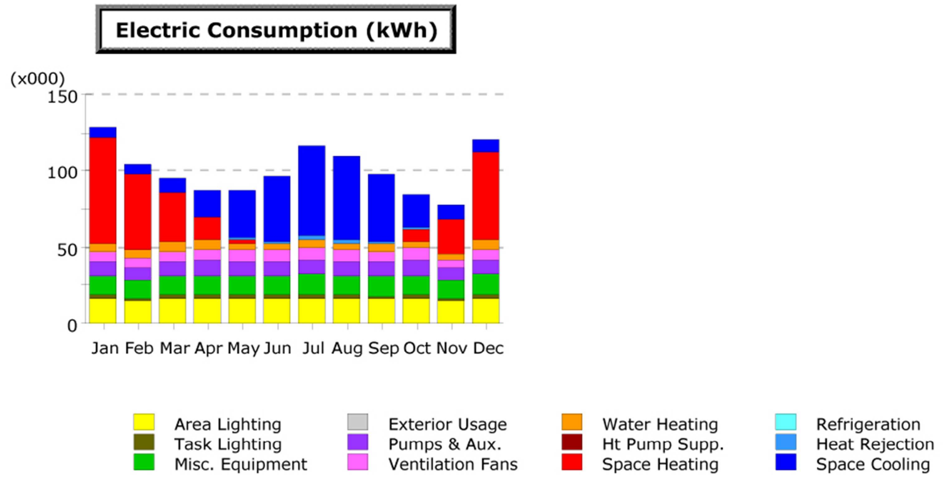
Categorization of the Parametric Runs Specified in the Original eQuest Model

The following parametric runs were specified -

1. New Walls and Shades – Overhangs enabled + *gwin wall* preset used
2. Sod Roof – Constructions preset *sod roof* enabled.
3. Chiller EER – Chiller EER assumed to be 17
4. Daylight On – Daylighting sensors enabled for all zones.
5. AFg Glass – Glass type AFG Gwinnett GT enabled.
6. Spacer – Frame spacer type insulated and frame conductance of 0.3 Btu/h-ft2-℉
7. LPD – Display, Mech, Classroom and Office zones given LPD of 1.03
8. Occupancy Sensors – Occupancy sensors modeled as 15% reduction in lighting schedule.
9. Humctrlrun – The humidity control parameter was set to a value of 60.

New Walls and Shades

Project/Run: Gwin DEC_revised - 1 Run Date/Time: 05/16/11 @ 17:35



Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	6.1	7.2	9.6	17.9	30.5	42.2	59.8	54.5	43.9	22.3	9.0	8.1	311.0
Heat Reject.	0.0	-	0.0	0.1	0.6	1.3	2.5	2.1	1.4	0.3	0.0	0.0	8.2
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	69.3	49.4	32.7	15.2	2.5	0.1	-	-	0.3	8.5	22.3	57.6	258.0
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	5.6	5.2	5.7	5.8	5.2	4.8	4.7	4.3	4.3	4.8	4.3	5.5	60.1
Vent. Fans	6.6	6.0	6.6	7.1	7.2	7.6	8.3	7.9	7.4	7.1	5.7	6.9	84.4
Pumps & Aux.	9.9	8.9	9.9	10.4	9.9	9.9	10.4	9.9	9.9	10.4	8.5	10.4	118.1
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	12.4	11.1	12.2	12.4	12.3	12.1	12.6	12.2	12.1	12.6	11.1	12.6	145.9
Task Lights	2.4	2.2	2.4	2.5	2.4	2.4	2.5	2.4	2.4	2.5	2.1	2.5	28.6
Area Lights	15.8	14.4	16.1	16.3	16.0	15.9	16.3	16.1	15.7	16.3	14.4	16.3	189.6
Total	128.1	104.4	95.2	87.5	86.5	96.2	117.1	109.5	97.4	84.8	77.3	120.0	1,203.9

Gas Consumption (Btu)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool													
Heat Reject.													
Refrigeration													
Space Heat													
HP Supp.													
Hot Water													
Vent. Fans													
Pumps & Aux.													
Ext. Usage													
Misc. Equip.													
Task Lights													
Area Lights													
Total													

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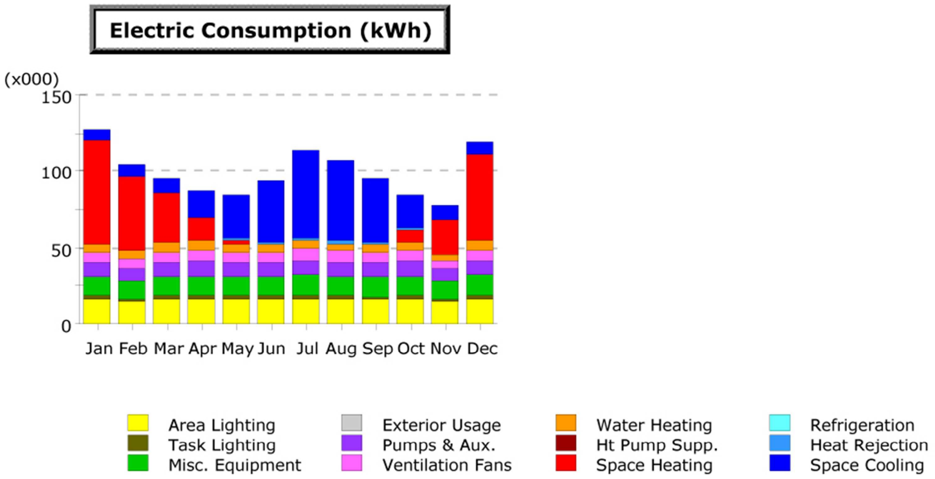
Figure 23 – Result of Parametric Run - New Walls and Shades

Sod Roof

Project/Run: Gwin DEC_revised - 2 Run Date/Time: 05/16/11 @ 17:35



Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	6.1	7.1	9.4	17.1	28.9	40.3	57.1	52.2	42.2	21.6	8.8	8.1	299.0
Heat Reject.	0.0	-	0.0	0.1	0.5	1.2	2.4	2.0	1.3	0.3	0.0	0.0	7.8
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	68.5	49.1	33.0	15.6	2.6	0.1	-	-	0.3	8.5	22.3	56.6	256.6
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	5.6	5.2	5.7	5.8	5.2	4.8	4.7	4.3	4.3	4.8	4.3	5.5	60.1
Vent. Fans	6.6	6.0	6.6	7.0	6.9	7.3	7.9	7.5	7.2	7.1	5.7	6.9	82.8
Pumps & Aux.	9.9	8.9	9.9	10.4	9.9	9.9	10.4	9.9	9.9	10.4	8.5	10.4	118.1
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	12.4	11.1	12.2	12.4	12.3	12.1	12.6	12.2	12.1	12.6	11.1	12.6	145.9
Task Lights	2.4	2.2	2.4	2.5	2.4	2.4	2.5	2.4	2.4	2.5	2.1	2.5	28.6
Area Lights	15.8	14.4	16.1	16.3	16.0	15.9	16.3	16.1	15.7	16.3	14.4	16.3	189.6
Total	127.2	104.1	95.3	87.1	84.6	93.9	113.9	106.7	95.5	84.0	77.1	119.0	1,188.3

Gas Consumption (Btu)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool													
Heat Reject.													
Refrigeration													
Space Heat													
HP Supp.													
Hot Water													
Vent. Fans													
Pumps & Aux.													
Ext. Usage													
Misc. Equip.													
Task Lights													
Area Lights													
Total													

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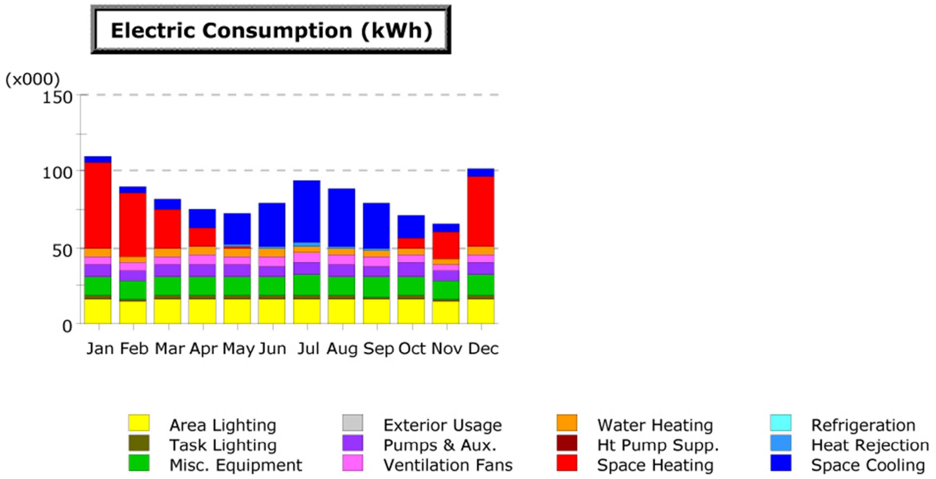
Figure 24 - Result of Parametric Run - Sod Roof

Chiller EER

Project/Run: Gwin DEC_revised - 3 Run Date/Time: 05/16/11 @ 17:35



Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	3.9	4.6	6.1	11.6	20.1	28.3	40.1	36.8	29.8	14.9	5.8	5.2	207.2
Heat Reject.	0.0	-	0.0	0.1	0.5	1.0	2.0	1.7	1.2	0.2	0.0	0.0	6.7
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	57.1	40.6	26.1	11.9	1.7	0.1	-	-	0.2	5.8	17.0	46.3	206.8
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	5.6	5.2	5.7	5.8	5.2	4.8	4.7	4.3	4.3	4.8	4.3	5.5	60.1
Vent. Fans	5.3	4.8	5.3	5.7	5.8	6.3	6.9	6.6	6.1	5.8	4.5	5.6	68.7
Pumps & Aux.	7.8	7.1	7.8	8.2	7.8	7.8	8.2	7.8	7.8	8.2	6.7	8.2	93.2
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	12.4	11.1	12.2	12.4	12.3	12.1	12.6	12.2	12.1	12.6	11.1	12.6	145.9
Task Lights	2.4	2.2	2.4	2.5	2.4	2.4	2.5	2.4	2.4	2.5	2.1	2.5	28.6
Area Lights	15.8	14.4	16.1	16.3	16.0	15.9	16.3	16.1	15.7	16.3	14.4	16.3	189.6
Total	110.2	89.9	81.8	74.3	71.8	78.7	93.3	87.9	79.6	71.1	65.8	102.2	1,006.6

Gas Consumption (Btu)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool													
Heat Reject.													
Refrigeration													
Space Heat													
HP Supp.													
Hot Water													
Vent. Fans													
Pumps & Aux.													
Ext. Usage													
Misc. Equip.													
Task Lights													
Area Lights													
Total													

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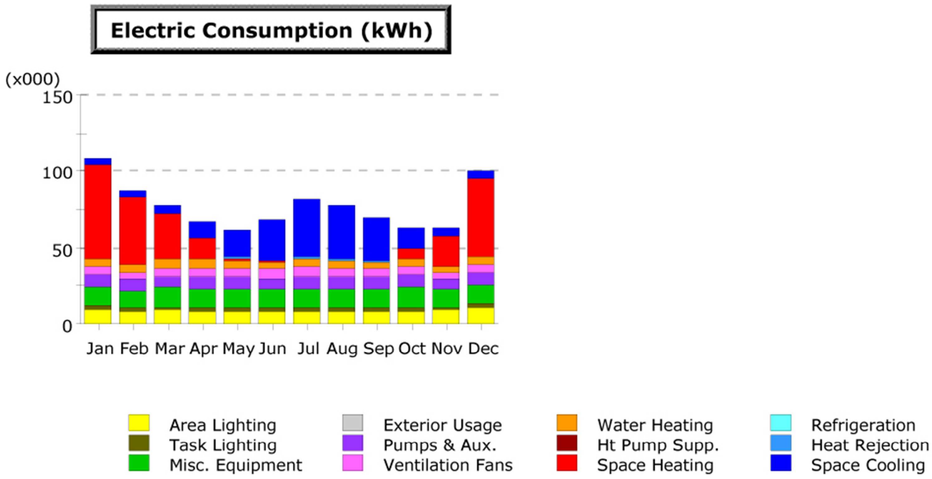
Figure 25 - Result of Parametric Run - Chiller EER

Daylight on

Project/Run: Gwin DEC_revised - 4 | Run Date/Time: 05/16/11 @ 17:35



Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	3.86	4.46	5.86	10.77	18.52	26.47	37.85	34.59	27.75	13.80	5.56	5.07	194.55
Heat Reject.	0.00	-	0.00	0.08	0.42	0.93	1.86	1.61	1.05	0.20	0.00	0.00	6.15
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	61.36	44.06	29.66	13.86	2.07	0.09	-	-	0.21	6.85	19.29	50.19	227.63
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	5.60	5.18	5.67	5.76	5.16	4.78	4.70	4.34	4.33	4.76	4.29	5.51	60.09
Vent. Fans	5.30	4.80	5.30	5.59	5.55	5.93	6.48	6.14	5.80	5.64	4.54	5.55	66.63
Pumps & Aux.	7.79	7.05	7.79	8.17	7.79	7.79	8.17	7.79	7.79	8.17	6.68	8.17	93.16
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	12.36	11.12	12.21	12.41	12.29	12.06	12.64	12.21	12.13	12.64	11.15	12.64	145.87
Task Lights	2.39	2.16	2.39	2.51	2.39	2.39	2.51	2.39	2.39	2.51	2.05	2.51	28.59
Area Lights	9.90	8.52	8.85	8.10	7.87	7.81	8.02	8.03	7.91	8.69	8.99	10.43	103.13
Total	108.57	87.34	77.73	67.24	62.07	68.27	82.23	77.11	69.38	63.25	62.55	100.07	925.80

Gas Consumption (Btu)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool													
Heat Reject.													
Refrigeration													
Space Heat													
HP Supp.													
Hot Water													
Vent. Fans													
Pumps & Aux.													
Ext. Usage													
Misc. Equip.													
Task Lights													
Area Lights													
Total													

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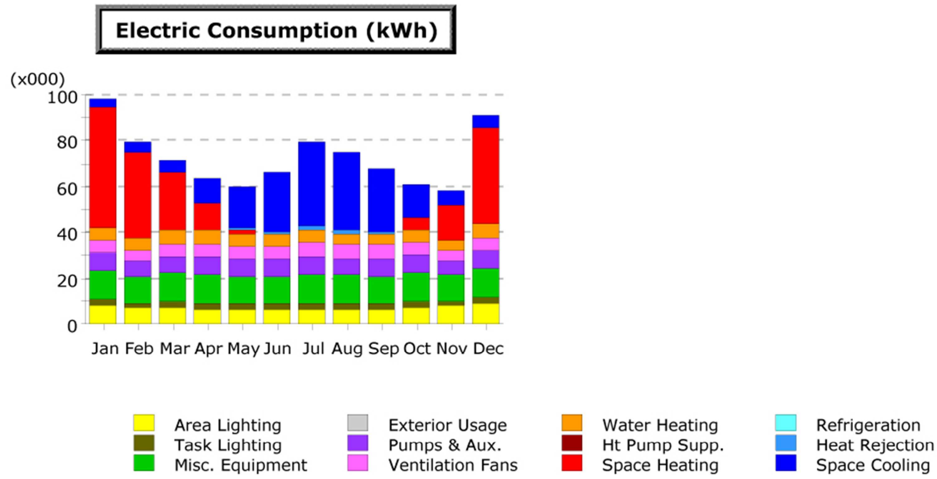
Figure 26 - Result of Parametric Run - Daylight on

AFg Glass

Project/Run: Gwin DEC_revised - 5	Run Date/Time: 05/16/11 @ 17:35



Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	3.89	4.52	5.93	10.82	18.35	25.95	36.99	33.94	27.61	13.98	5.68	5.18	192.83
Heat Reject.	0.00	-	0.00	0.08	0.40	0.91	1.82	1.58	1.04	0.20	0.00	0.00	6.04
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	52.83	37.90	25.22	11.83	1.87	0.09	-	-	0.19	5.48	15.65	42.24	193.30
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	5.60	5.18	5.67	5.76	5.16	4.78	4.70	4.34	4.33	4.76	4.29	5.51	60.09
Vent. Fans	5.30	4.79	5.30	5.58	5.53	5.86	6.35	6.05	5.79	5.64	4.54	5.55	66.29
Pumps & Aux.	7.80	7.05	7.80	8.17	7.80	7.80	8.17	7.80	7.80	8.17	6.68	8.17	93.19
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	12.36	11.12	12.21	12.41	12.29	12.06	12.64	12.21	12.13	12.64	11.15	12.64	145.87
Task Lights	2.39	2.16	2.39	2.51	2.39	2.39	2.51	2.39	2.39	2.51	2.05	2.51	28.59
Area Lights	8.46	7.09	7.29	6.47	6.26	6.17	6.37	6.43	6.46	7.19	7.79	9.02	84.98
Total	98.64	79.82	71.81	63.62	60.05	66.01	79.55	74.74	67.74	60.57	57.83	90.81	871.19

Gas Consumption (Btu)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool													
Heat Reject.													
Refrigeration													
Space Heat													
HP Supp.													
Hot Water													
Vent. Fans													
Pumps & Aux.													
Ext. Usage													
Misc. Equip.													
Task Lights													
Area Lights													
Total													

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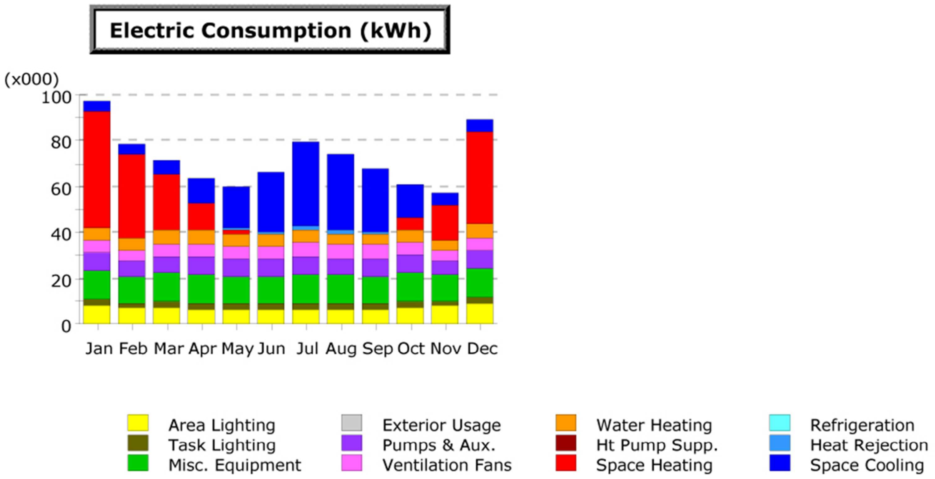
Figure 27 - Result of Parametric Run - AFg Glass

Spacer



Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	3.90	4.53	5.94	10.81	18.27	25.76	36.72	33.72	27.51	14.00	5.70	5.20	192.06
Heat Reject.	0.00	-	0.00	0.08	0.40	0.90	1.81	1.57	1.03	0.20	0.00	0.00	5.99
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	51.26	36.79	24.47	11.51	1.85	0.09	-	-	0.19	5.29	15.02	40.78	187.24
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	5.60	5.18	5.67	5.76	5.16	4.78	4.70	4.34	4.33	4.76	4.29	5.51	60.09
Vent. Fans	5.30	4.79	5.30	5.58	5.52	5.83	6.32	6.02	5.77	5.64	4.54	5.55	66.17
Pumps & Aux.	7.80	7.05	7.80	8.17	7.80	7.80	8.17	7.80	7.80	8.17	6.68	8.17	93.19
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	12.36	11.12	12.21	12.41	12.29	12.06	12.64	12.21	12.13	12.64	11.15	12.64	145.87
Task Lights	2.39	2.16	2.39	2.51	2.39	2.39	2.51	2.39	2.39	2.51	2.05	2.51	28.59
Area Lights	8.46	7.09	7.29	6.47	6.26	6.17	6.37	6.43	6.46	7.19	7.79	9.02	84.98
Total	97.08	78.72	71.07	63.30	59.92	65.79	79.23	74.48	67.61	60.40	57.22	89.38	864.20

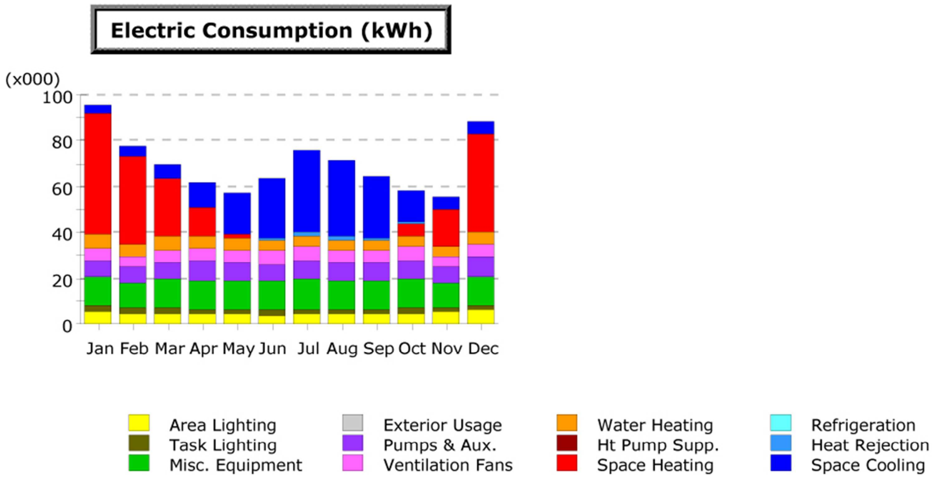
Gas Consumption (Btu)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool													
Heat Reject.													
Refrigeration													
Space Heat													
HP Supp.													
Hot Water													
Vent. Fans													
Pumps & Aux.													
Ext. Usage													
Misc. Equip.													
Task Lights													
Area Lights													
Total													

Figure 28 - Result of Parametric Run – Spacer

LPD

Project/Run: Gwin DEC_revised - 7 Run Date/Time: 05/16/11 @ 17:35



Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	3.88	4.48	5.87	10.60	17.89	25.24	36.04	33.10	26.91	13.69	5.61	5.15	188.46
Heat Reject.	0.00	-	0.00	0.07	0.38	0.87	1.78	1.54	1.00	0.19	0.00	0.00	5.84
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	53.15	38.20	25.77	12.18	2.01	0.10	-	-	0.21	5.76	16.21	42.75	196.35
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	5.60	5.18	5.67	5.76	5.16	4.78	4.70	4.34	4.33	4.76	4.29	5.51	60.09
Vent. Fans	5.30	4.79	5.30	5.57	5.48	5.77	6.25	5.95	5.72	5.62	4.54	5.55	65.85
Pumps & Aux.	7.80	7.05	7.80	8.17	7.80	7.80	8.17	7.80	7.80	8.17	6.68	8.17	93.19
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	12.36	11.12	12.21	12.41	12.29	12.06	12.64	12.21	12.13	12.64	11.15	12.64	145.87
Task Lights	2.39	2.16	2.39	2.51	2.39	2.39	2.51	2.39	2.39	2.51	2.05	2.51	28.59
Area Lights	5.45	4.57	4.70	4.16	4.03	3.97	4.10	4.14	4.16	4.63	5.01	5.80	54.71
Total	95.93	77.56	69.71	61.44	57.42	62.99	76.18	71.46	64.64	57.98	55.56	88.08	838.96

Gas Consumption (Btu)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool													
Heat Reject.													
Refrigeration													
Space Heat													
HP Supp.													
Hot Water													
Vent. Fans													
Pumps & Aux.													
Ext. Usage													
Misc. Equip.													
Task Lights													
Area Lights													
Total													

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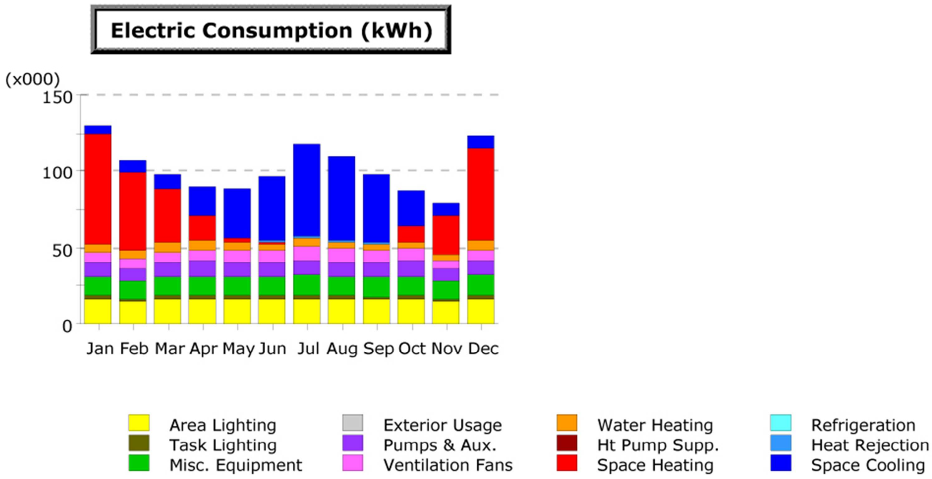
Figure 29 - Result of Parametric Run – LPD

humctrlRun

Project/Run: Gwin DEC_revised - 9 Run Date/Time: 05/16/11 @ 17:35



Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	6.2	7.4	9.8	18.3	31.2	42.6	60.1	54.9	44.2	22.7	9.1	8.2	314.4
Heat Reject.	0.0	-	0.0	0.1	0.6	1.3	2.5	2.1	1.4	0.3	0.0	0.0	8.3
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	71.7	51.7	35.0	16.7	2.9	0.2	-	-	0.4	10.1	24.2	60.3	273.1
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	5.6	5.2	5.7	5.8	5.2	4.8	4.7	4.3	4.3	4.8	4.3	5.5	60.1
Vent. Fans	6.7	6.0	6.7	7.4	7.4	7.9	9.1	8.5	7.8	7.4	5.8	7.0	87.7
Pumps & Aux.	9.9	8.9	9.9	10.3	9.9	9.9	10.3	9.9	9.9	10.3	8.5	10.3	118.1
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	12.4	11.1	12.2	12.4	12.3	12.1	12.6	12.2	12.1	12.6	11.1	12.6	145.9
Task Lights	2.4	2.2	2.4	2.5	2.4	2.4	2.5	2.4	2.4	2.5	2.1	2.5	28.6
Area Lights	15.8	14.4	16.1	16.3	16.0	15.9	16.3	16.1	15.7	16.3	14.4	16.3	189.6
Total	130.5	106.9	97.8	89.7	87.8	96.8	118.2	110.4	98.2	87.0	79.5	122.8	1,225.8

Gas Consumption (Btu)

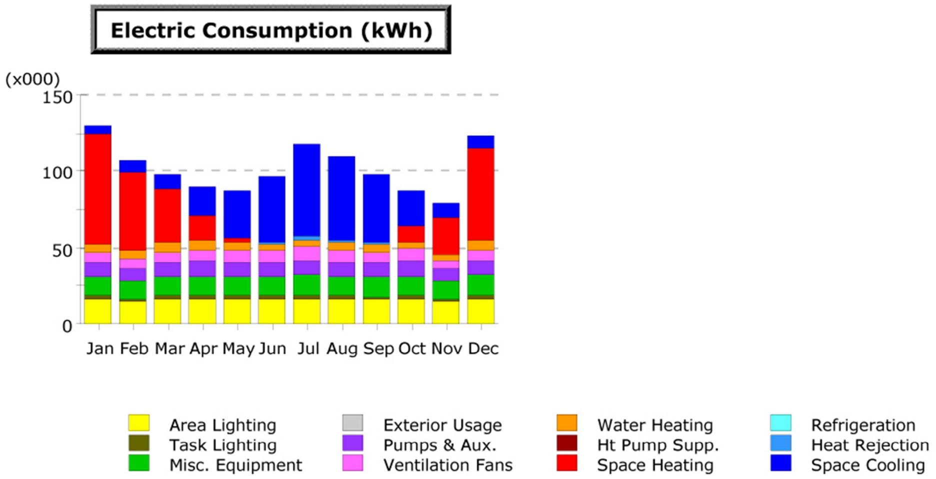
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool													
Heat Reject.													
Refrigeration													
Space Heat													
HP Supp.													
Hot Water													
Vent. Fans													
Pumps & Aux.													
Ext. Usage													
Misc. Equip.													
Task Lights													
Area Lights													
Total													

eQUEST 3.64.7130 Monthly Energy Consumption by Enduse Page 1

Figure 30 - Result of Parametric Run – humctrlRun

Baseline Design

Project/Run: Gwin DEC_revised - Baseline Design　　　　Run Date/Time: 05/16/11 @ 17:34



Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	6.2	7.4	9.8	18.2	31.1	42.5	60.0	54.8	44.1	22.6	9.1	8.2	313.9
Heat Reject.	0.0	-	0.0	0.1	0.6	1.3	2.5	2.1	1.4	0.3	0.0	0.0	8.3
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	71.7	51.7	35.0	16.6	2.9	0.2	-	-	0.4	10.0	24.2	60.3	272.8
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	5.6	5.2	5.7	5.8	5.2	4.8	4.7	4.3	4.3	4.8	4.3	5.5	60.1
Vent. Fans	6.6	6.0	6.7	7.1	7.3	7.7	8.4	7.9	7.4	7.2	5.7	6.9	85.1
Pumps & Aux.	9.9	8.9	9.9	10.3	9.9	9.9	10.3	9.9	9.9	10.3	8.5	10.3	118.1
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	12.4	11.1	12.2	12.4	12.3	12.1	12.6	12.2	12.1	12.6	11.1	12.6	145.9
Task Lights	2.4	2.2	2.4	2.5	2.4	2.4	2.5	2.4	2.4	2.5	2.1	2.5	28.6
Area Lights	15.8	14.4	16.1	16.3	16.0	15.9	16.3	16.1	15.7	16.3	14.4	16.3	189.6
Total	130.5	106.8	97.7	89.4	87.5	96.6	117.4	109.9	97.7	86.7	79.3	122.7	1,222.3

Gas Consumption (Btu)

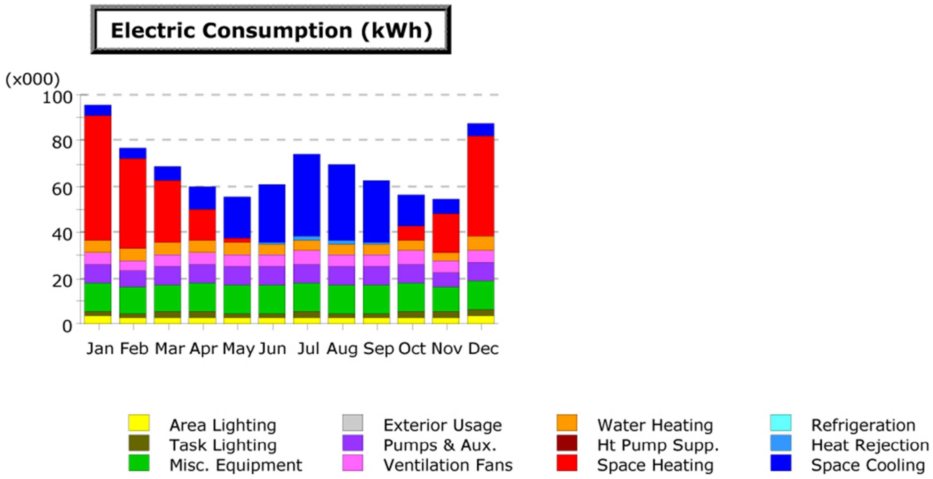
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool													
Heat Reject.													
Refrigeration													
Space Heat													
HP Supp.													
Hot Water													
Vent. Fans													
Pumps & Aux.													
Ext. Usage													
Misc. Equip.													
Task Lights													
Area Lights													
Total													

eQUEST 3.64.7130　　　　Monthly Energy Consumption by Enduse　　　　Page 1

Figure 31 - Result of Parametric Run - Baseline Design

Occupancy Sensors

Project/Run: Gwin DEC_revised - 8 | Run Date/Time: 05/16/11 @ 17:35



Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	3.86	4.45	5.83	10.44	17.63	24.88	35.58	32.67	26.49	13.50	5.56	5.11	186.01
Heat Reject.	0.00	-	0.00	0.07	0.37	0.85	1.76	1.52	0.98	0.18	0.00	0.00	5.73
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	54.47	39.19	26.74	12.67	2.12	0.11	-	-	0.22	6.14	17.08	44.13	202.87
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	5.60	5.18	5.67	5.76	5.16	4.78	4.70	4.34	4.33	4.76	4.29	5.51	60.09
Vent. Fans	5.30	4.79	5.30	5.57	5.46	5.74	6.20	5.91	5.68	5.61	4.54	5.55	65.65
Pumps & Aux.	7.80	7.05	7.80	8.17	7.80	7.80	8.17	7.80	7.80	8.17	6.68	8.17	93.19
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	12.36	11.12	12.21	12.41	12.29	12.06	12.64	12.21	12.13	12.64	11.15	12.64	145.87
Task Lights	2.39	2.16	2.39	2.51	2.39	2.39	2.51	2.39	2.39	2.51	2.05	2.51	28.59
Area Lights	3.31	2.73	2.73	2.51	2.35	2.31	2.47	2.37	2.49	2.80	2.86	3.61	32.55
Total	95.10	76.69	68.67	60.11	55.56	60.92	74.02	69.20	62.52	56.31	54.22	87.23	820.54

Gas Consumption (Btu)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool													
Heat Reject.													
Refrigeration													
Space Heat													
HP Supp.													
Hot Water													
Vent. Fans													
Pumps & Aux.													
Ext. Usage													
Misc. Equip.													
Task Lights													
Area Lights													
Total													

eQUEST 3.64.7130 | Monthly Energy Consumption by Enduse | Page 1

Figure 32 - Result of Parametric Run - Occupancy Sensors

APPENDIX C

DETAILS OF THE ACTUAL ENERGY CONSUMPTION DATA OF THE GEHC

Energy Consumption and Utility Charge Data for the GEHC

Table 23. EHC Electricity Actual Usage Report, by Year and Month, 2007-2011

	2007			2008			2009		
	Usage	Kw Cost	Total	Usage	Kw Cost	Total	Usage	Kw Cost	Total
Month	kWh Used	$	$	kWh Used	$	$	kWh Used	$	$
January	253560	3.53	15106	255960	4.41	17713	269880	3.53	18111
February	281130	3.76	16081	249720	3.75	17513	248160	4.23	17072
March	253440	3.67	16384	249720	3.75	17247	260640	3.76	17072
April	235920	4.11	15664	275400	4.04	18376	228960	4.12	16201
May	230280	3.45	15431	213960	3.42	15721	206640	3.42	15176
June	283680	3.62	17894	203760	3.18	15883	217320	3.18	15924
July	313560	3.76	19145	218400	3.56	16565	213360	3.65	16573
August	104040	3.65	10366	197880	3.14	15131	204720	3.20	15845
September	257880	3.27	16578	219840	3.18	16124	218040	3.71	17310
October	226440	3.45	15286	222000	3.38	15968	230400	3.87	17526
November	219480	3.56	14999	217680	3.18	15769	228360	3.80	17432
December	269880	3.53	16209	220115	3.46	16810	302520	4.26	20837
Average	**244107.5**	**3.61**		**228702.9**	**3.54**		**235750**	**3.73**	
Total	**2929290**			**2744435**			**2829000**		

Table 23 (Cont'd)

	2010			2011		
	Usage	**Kw Cost**	**Total**	**Usage**	**Kw Cost**	**Total**
Month	**kWh Used**	$	$	**kWh Used**	$	$
January	260400	3.91	18917	287880	4.53	24078
February	254880	3.73	18661	246720	3.99	21912
March	242280	3.79	18986	227880	4.08	20924
April	204360	3.14	17399	221880	4.23	20609
May	204360	3.97	18713	--	--	--
June	226080	4.15	20251	--	--	--
July	228600	4.26	20588	--	--	--
August	232800	4.14	20609	--	--	--
September	208080	3.98	18180	--	--	--
October	227040	3.90	19117	--	--	--
November	242520	4.55	19907	--	--	--
December	299880	4.10	23432	--	--	--
Average	**235940**	**3.97**		**246090**	**4.21**	
Total	**2831280**			**984360**		

APPENDIX D

COMPARISON OF THE ACTUAL USAGE WITH THE RESULTS OF SIMULATION

Comparison of the Actual Usage Data with Results from the Parametric Runs of the eQuest Model

Table 24 - Comparison of Actual Usage Data with the Results of the Parametric Runs of the eQuest Model

Profile	**Simulation Result** kwh	**2007 Total Usage** kwh	**Differ-ence** %	**2008 Total Usage** kwh	**Differ-ence** %	**2009 Total Usage** kwh	**Differ-ence** %	**2010 Total Usage** kwh	**Differ-ence** %
Baseline	1222270	2929290	58.27	2744435	55.46	2829000	56.79	2831280	56.83
New Walls and Shades	1204000	2929290	58.90	2747735	56.18	2829000	57.44	2831280	57.48
Sod Roof	1188400	2929290	59.43	2747735	56.75	2829000	57.99	2831280	58.03
Chiller EER	1006600	2929290	65.64	2747735	63.37	2829000	64.42	2831280	64.45
Daylight On	930760	2929290	68.23	2747735	66.13	2829000	67.10	2831280	67.13
Afg Glass	871190	2929290	70.26	2747735	68.29	2829000	69.21	2831280	69.23
Spacer	864200	2929290	70.50	2747735	68.55	2829000	69.45	2831280	69.48
LPD	838950	2929290	71.36	2747735	69.47	2829000	70.34	2831280	70.37
HumCtrlRun	1225600	2929290	58.16	2747735	55.40	2829000	56.68	2831280	56.71
Occupancy Sensors	820550	2929290	71.99	2747735	70.14	2829000	71.00	2831280	71.02
Current Operation	2669233	2929290	8.88	2747736	2.86	2829001	5.65	2831281	5.72

APPENDIX E

DAYLIGHTING ANALYSIS

Results of the Daylighting Analysis performed using the RadianceIES module of IES-VE Pro Version 6.4

The Bridge was chosen as the sample zone, and the north bay was analyzed for illuminance levels three times each day – 9:00 AM, 12:00 PM and 4:00 PM – for 15th of every month.

January 15, 2011

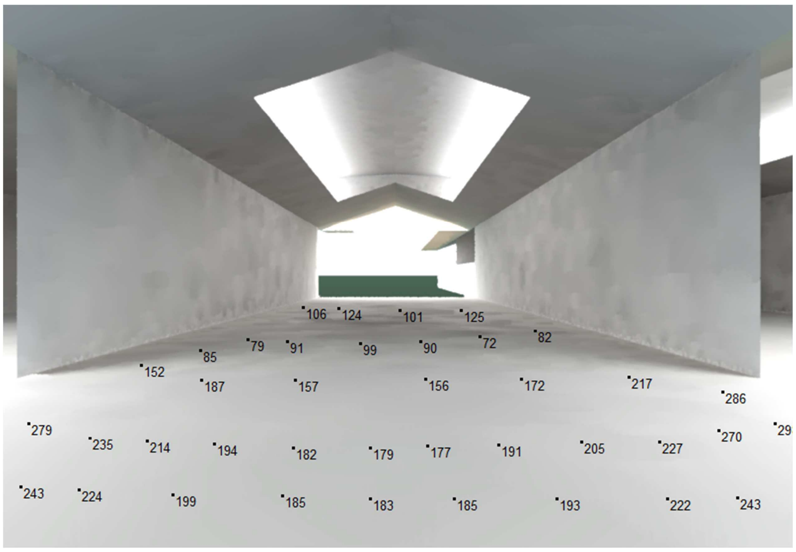


Figure 18 - January 15th 2011 Bridge North Bay 9:00 AM Illumination Levels (Lux)

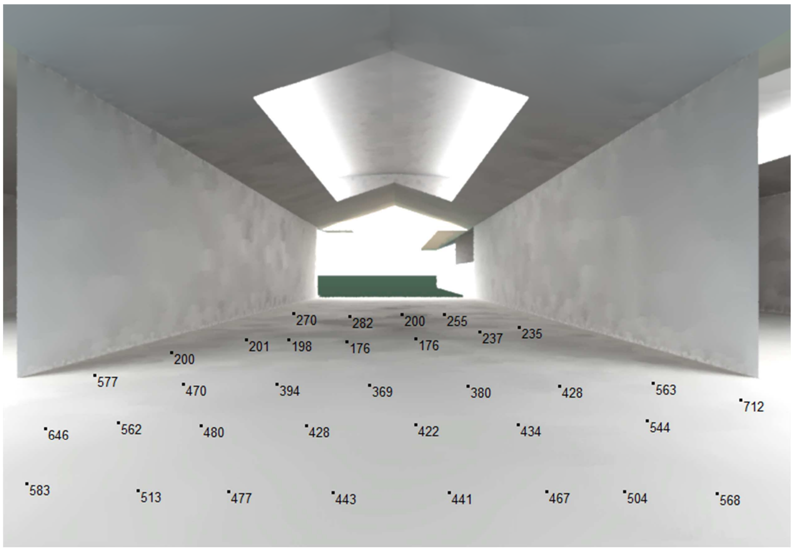


Figure 34 - January 15th 2011 Bridge North Bay 12:00 PM Illumination Levels (Lux)

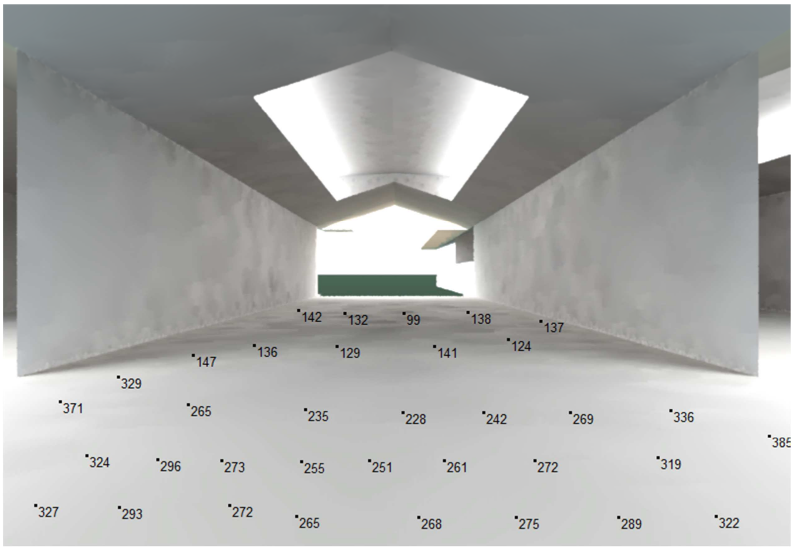


Figure 35 - January 15th 2011 Bridge North Bay 4:00 PM Illumination Levels (Lux)

Conclusion – Sufficient illumination levels available at all times

February 15, 2011

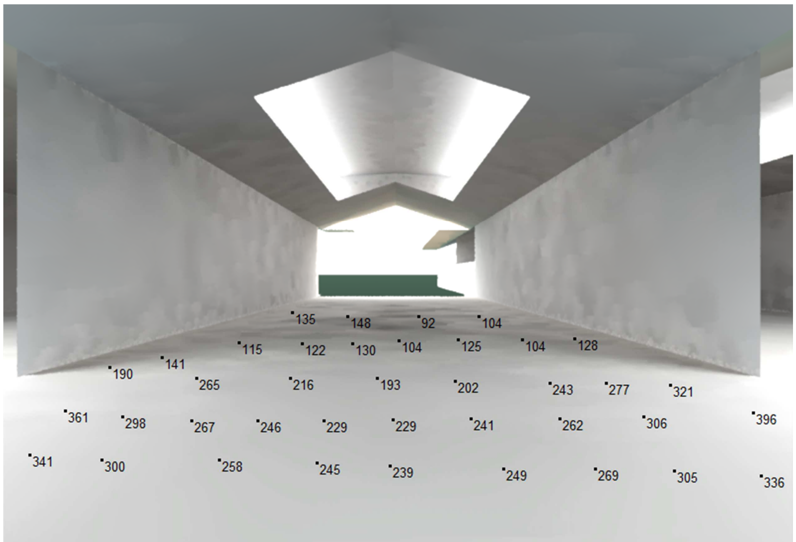


Figure 36 - February 15th 2011 Bridge North Bay 9:00 AM Illumination Levels (Lux)

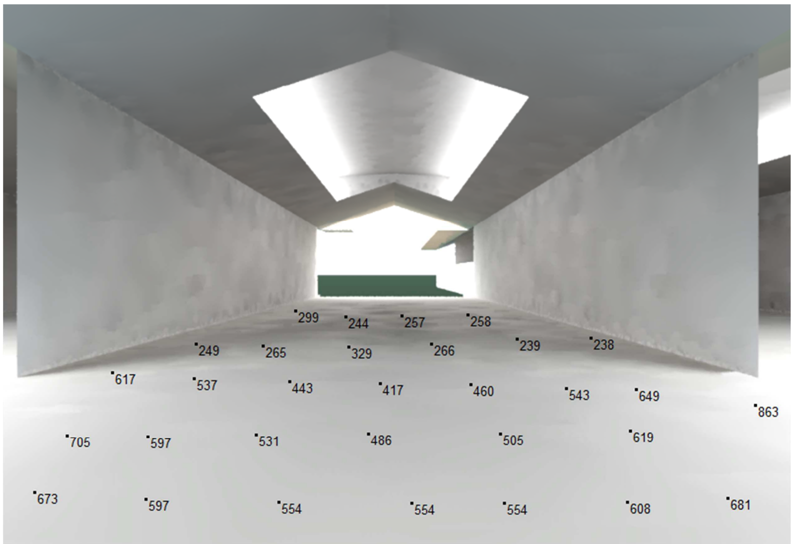


Figure 37 - February 15th 2011 Bridge North Bay 12:00 PM Illumination Levels (Lux)

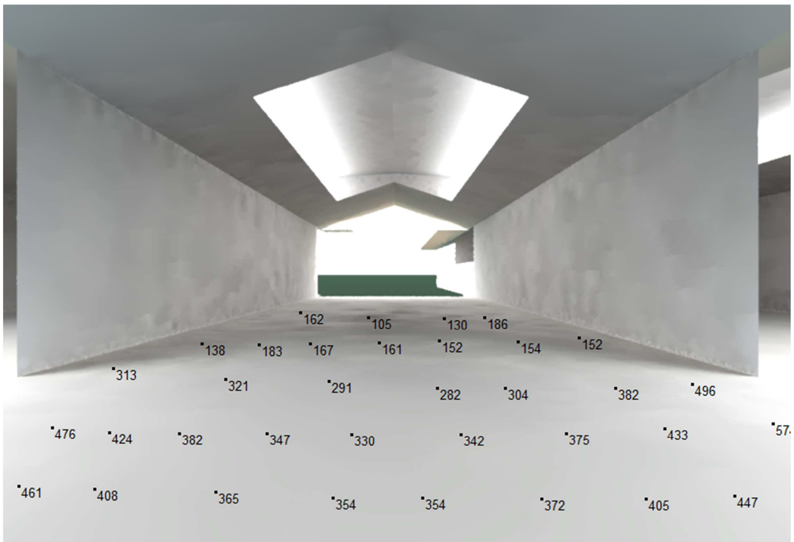


Figure 38 - February 15th 2011 Bridge North Bay 4:00 PM Illumination Levels (Lux)

Conclusion – Sufficient illumination levels available at all times

March 15, 2011

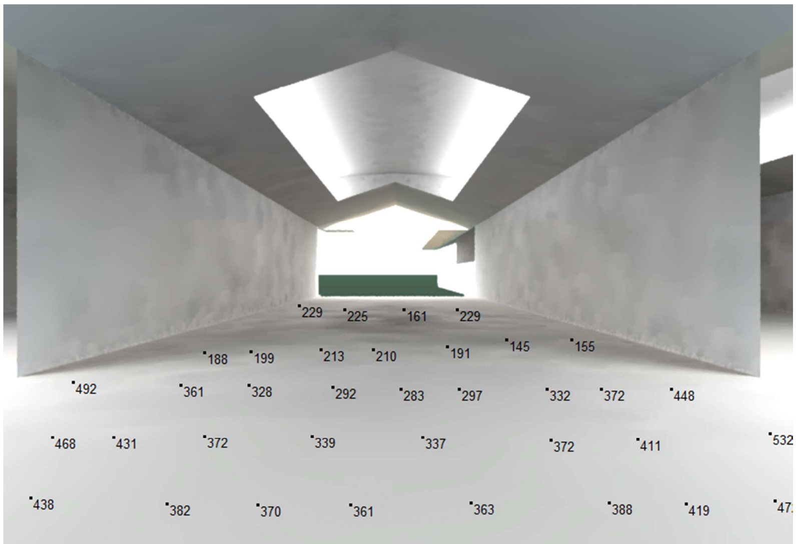


Figure 39 - March 15th 2011 Bridge North Bay 9:00 AM Illumination Levels (Lux)

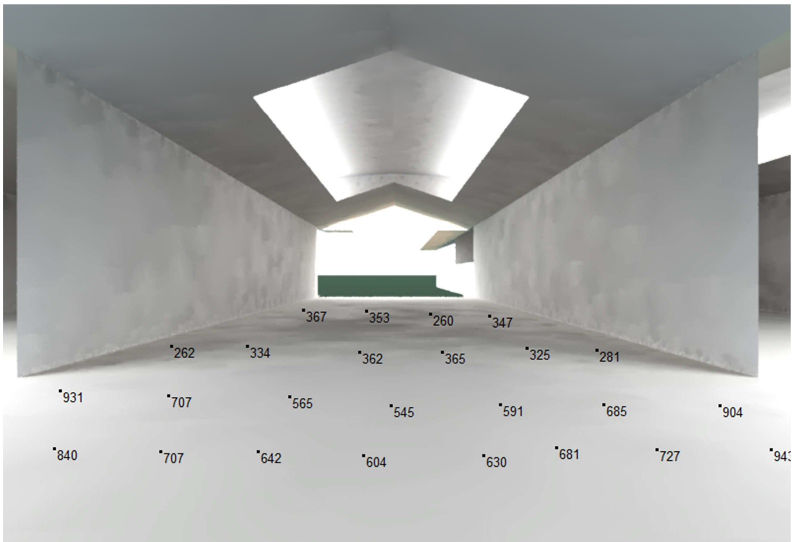


Figure 40 - March 15th 2011 Bridge North Bay 12:00 PM Illumination Levels (Lux)

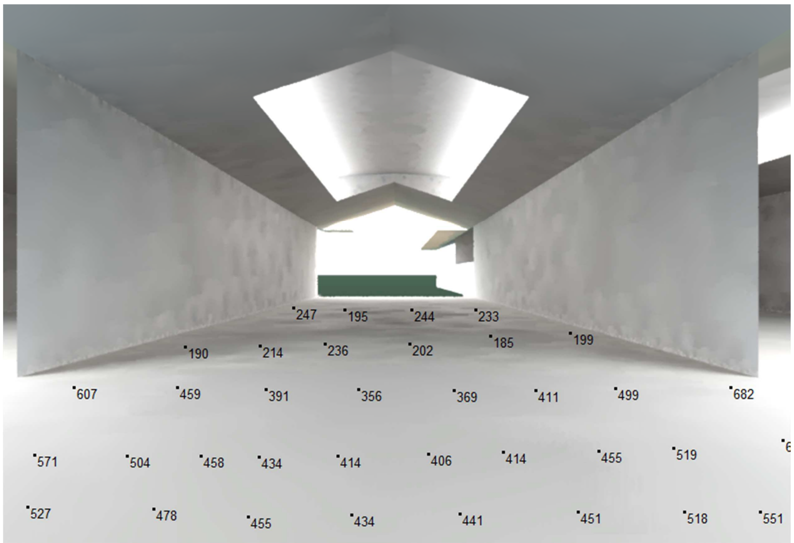


Figure 41 - March 15th 2011 Bridge North Bay 4:00 PM Illumination Levels (Lux)

Conclusion – Sufficient illumination levels available at all times

April 15, 2011

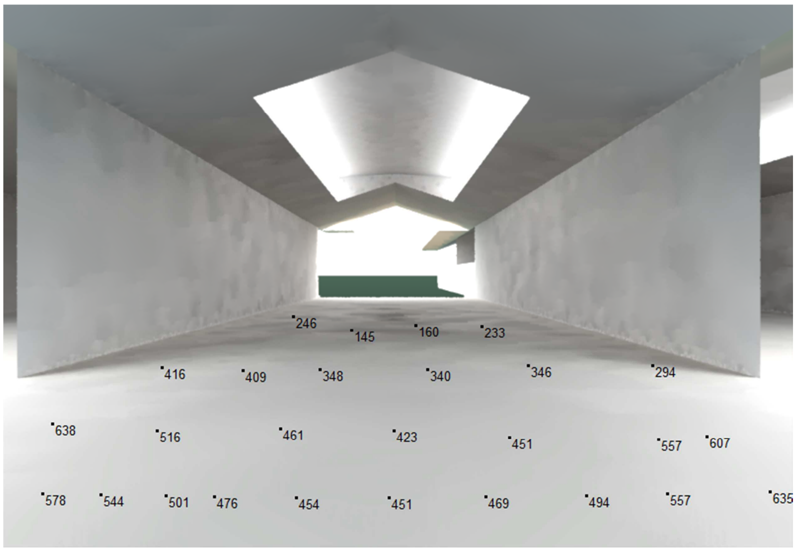


Figure 42 - April 15th 2011 Bridge North Bay 9:00 AM Illumination Levels (Lux)

Figure 43 - April 15th 2011 Bridge North Bay 12:00 PM Illumination Levels (Lux)

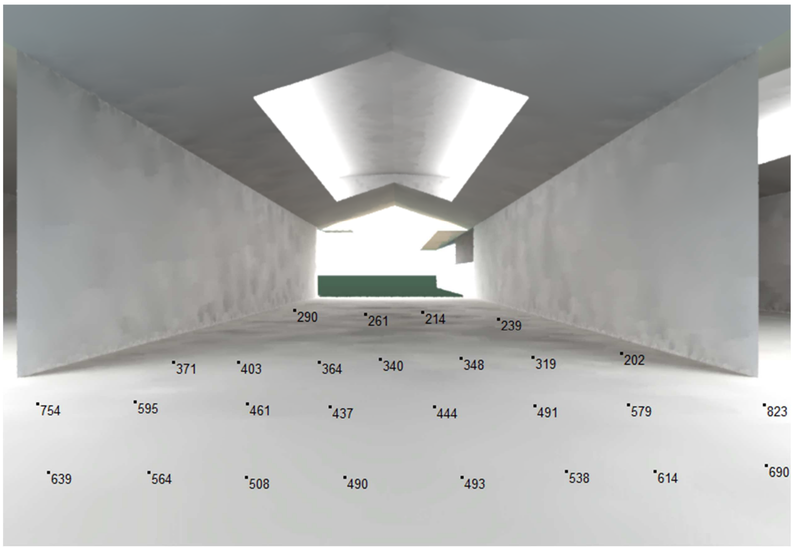


Figure 44 - April 15th 2011 Bridge North Bay 4:00 PM Illumination Levels (Lux)

Conclusion – Sufficient illumination levels available at all times

May 15, 2011

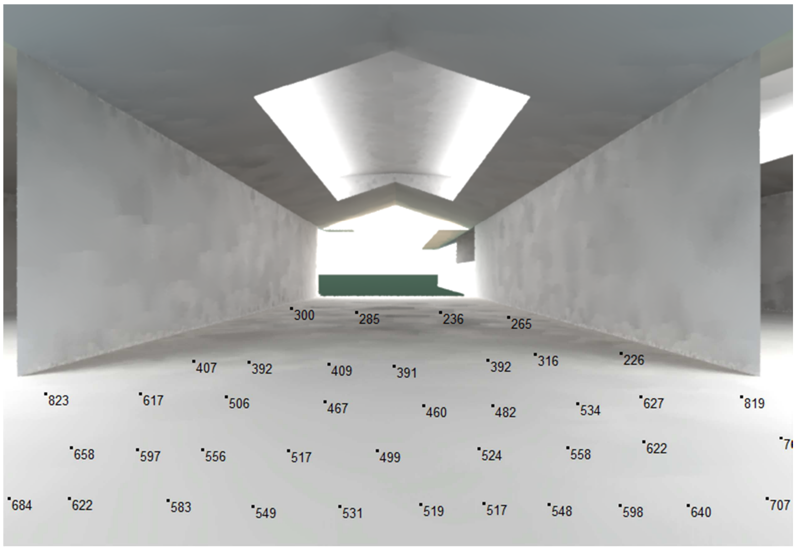


Figure 45 - May 15th 2011 Bridge North Bay 9:00 AM Illumination Levels (Lux)

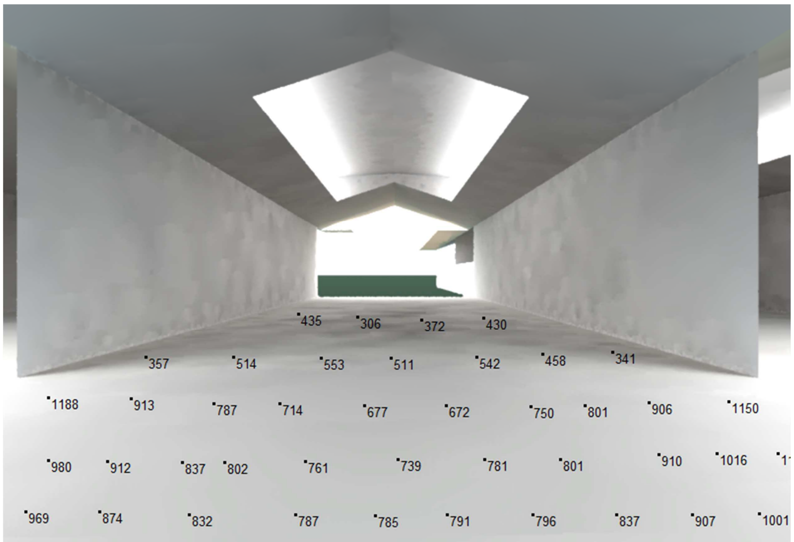


Figure 46 - May 15th 2011 Bridge North Bay 12:00 PM Illumination Levels (Lux)

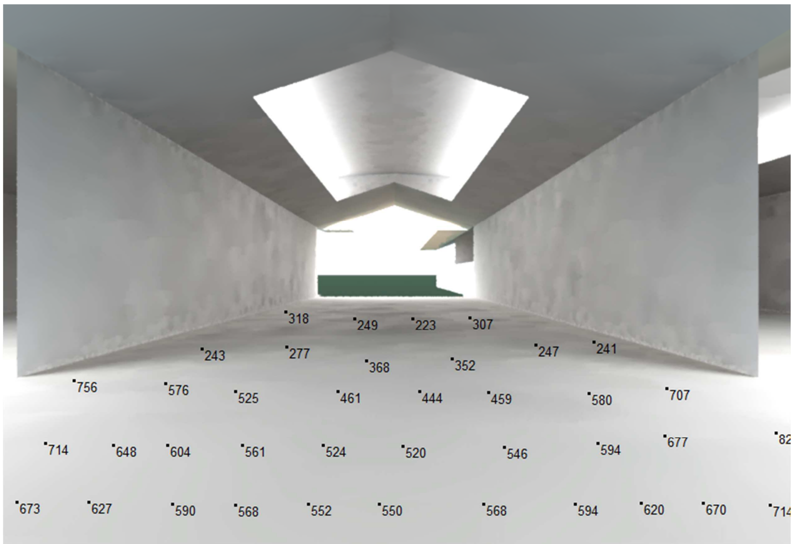


Figure 47 - May 15th 2011 Bridge North Bay 4:00 PM Illumination Levels (Lux)

Conclusion – Sufficient illumination levels available at all times

June 15, 2011

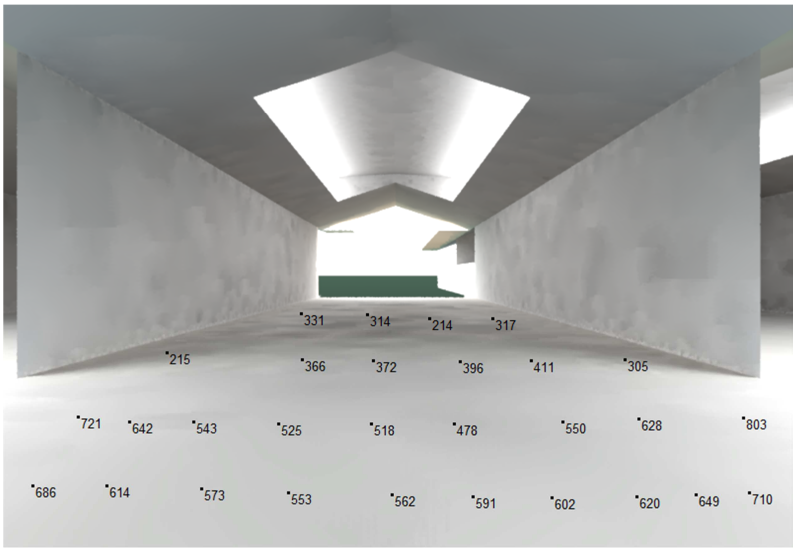


Figure 48 - June 15th 2011 Bridge North Bay 9:00 AM Illumination Levels (Lux)

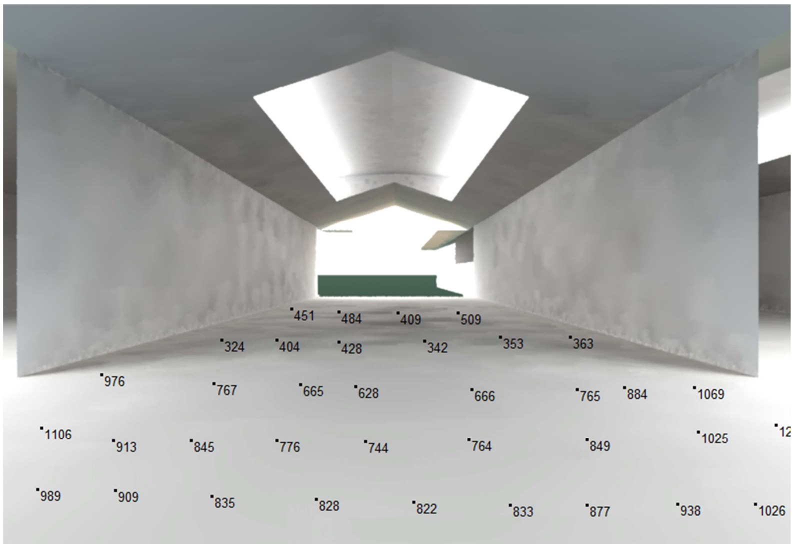


Figure 49 - June 15th 2011 Bridge North Bay 12:00 PM Illumination Levels (Lux)

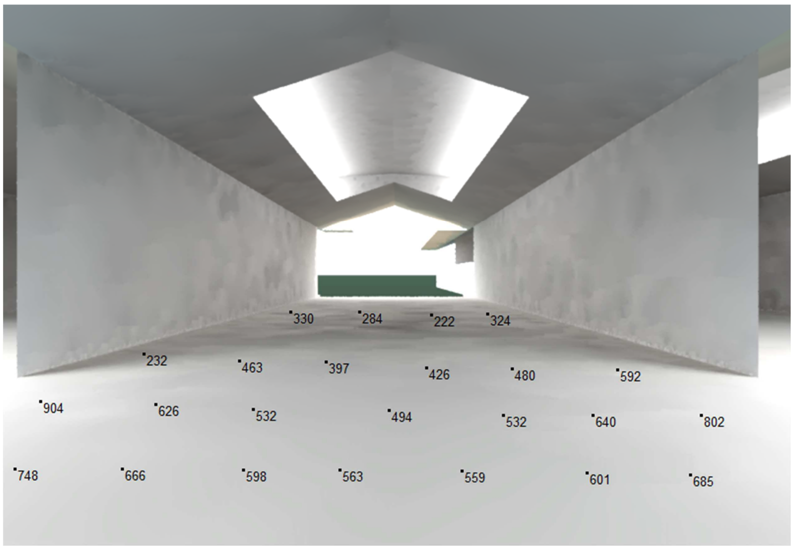


Figure 50 - June 15th 2011 Bridge North Bay 4:00 PM Illumination Levels (Lux)

Conclusion – Sufficient illumination levels available at all times

July 15, 2011

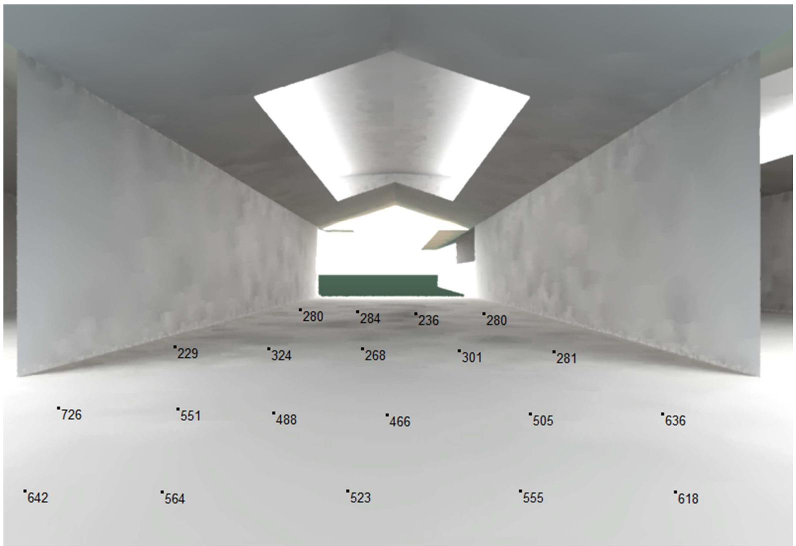


Figure 51 - July 15th 2011 Bridge North Bay 9:00 AM Illumination Levels (Lux)

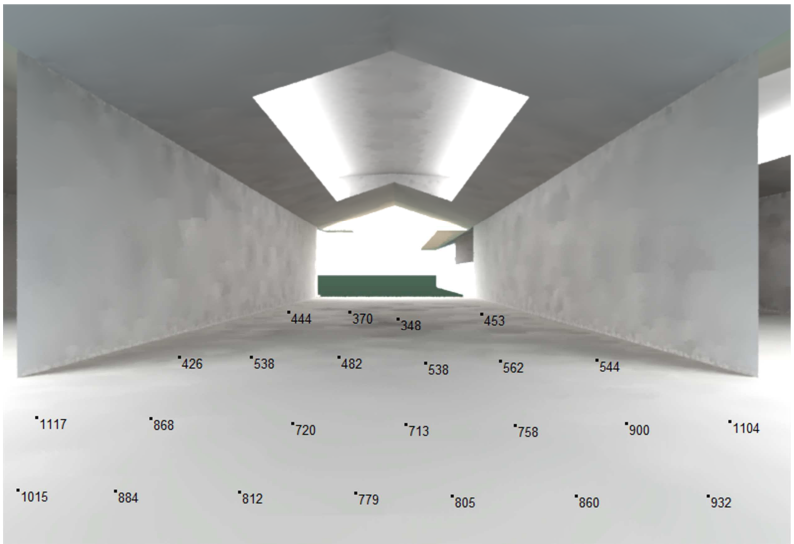


Figure 52 - July 15th 2011 Bridge North Bay 12:00 PM Illumination Levels (Lux)

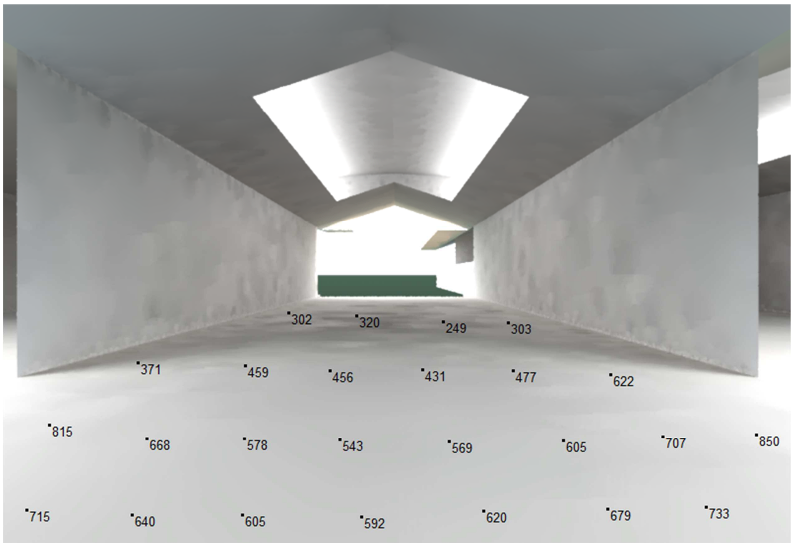


Figure 53 - July 15th 2011 Bridge North Bay 4:00 PM Illumination Levels (Lux)

Conclusion – Sufficient illumination levels available at all times

August 15, 2011

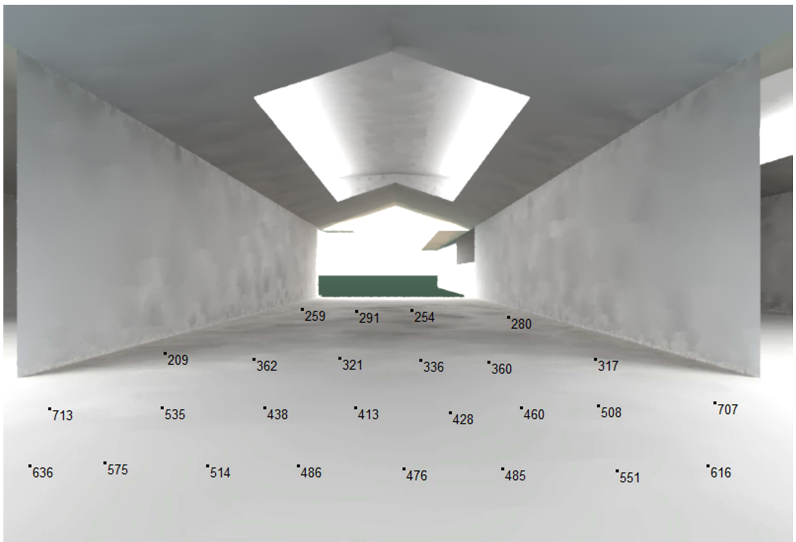


Figure 54 - August 15th 2011 Bridge North Bay 9:00 AM Illumination Levels (Lux)

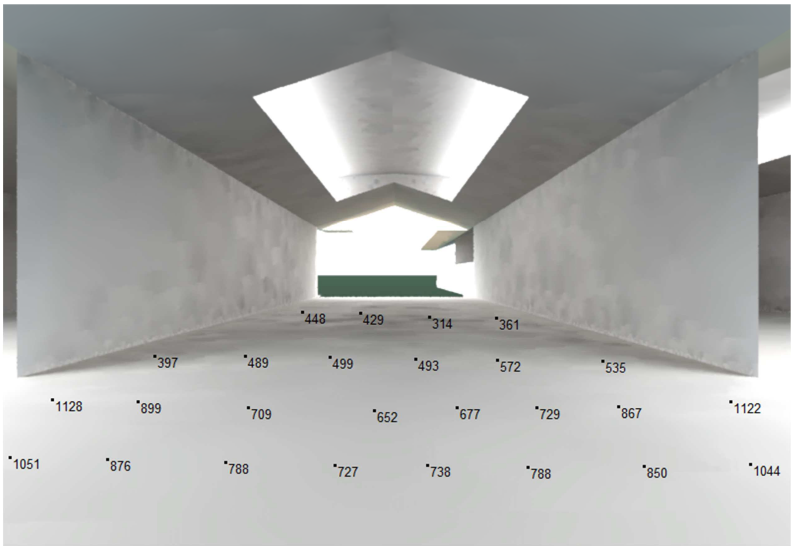


Figure 55 - August 15th 2011 Bridge North Bay 12:00 PM Illumination Levels (Lux)

Figure 56 - August 15th 2011 Bridge North Bay 4:00 PM Illumination Levels (Lux)

Conclusion – Sufficient illumination levels available at all times

September 15, 2011

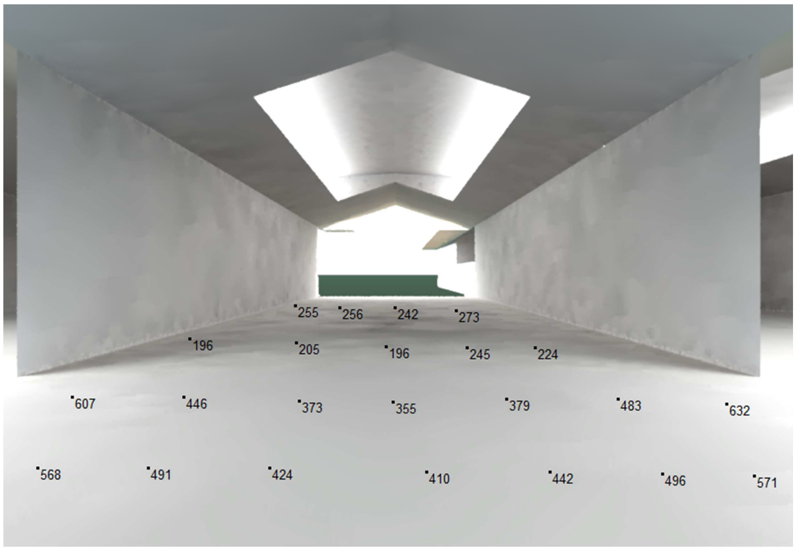


Figure 57 - September 15th 2011 Bridge North Bay 9:00 AM Illumination Levels (Lux)

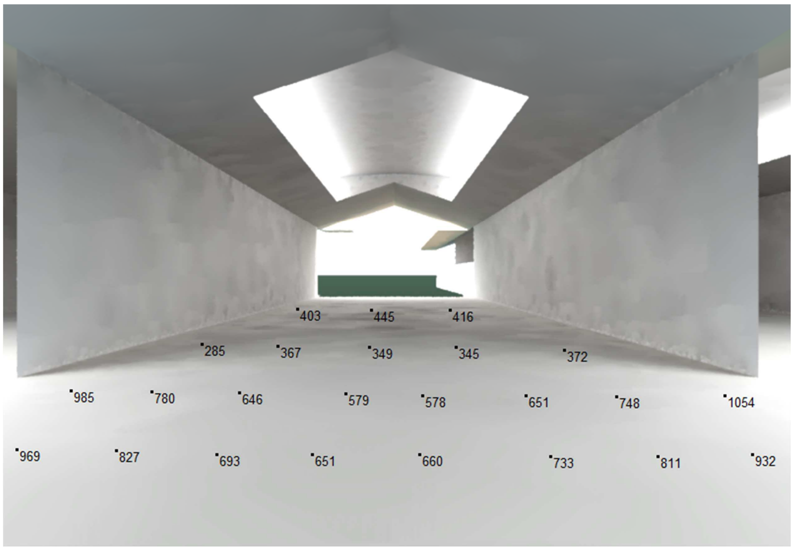


Figure 58 - September 15th 2011 Bridge North Bay 12:00 PM Illumination Levels (Lux)

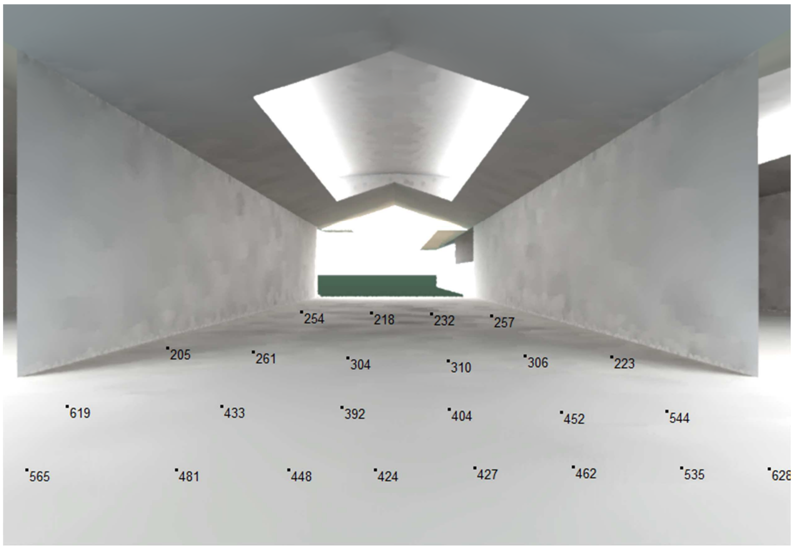


Figure 59 - September 15th 2011 Bridge North Bay 4:00 PM Illumination Levels (Lux)

Conclusion – Sufficient illumination levels available at all times

October 15, 2011

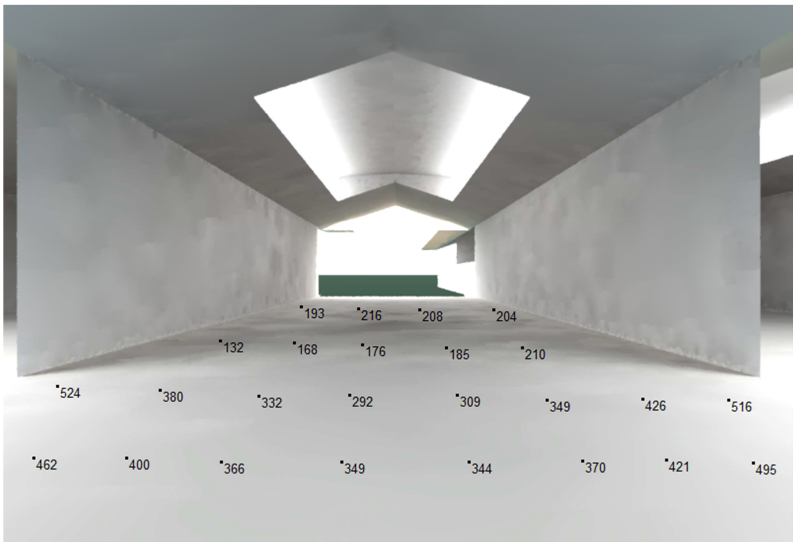


Figure 60 - October 15th 2011 Bridge North Bay 9:00 AM Illumination Levels (Lux)

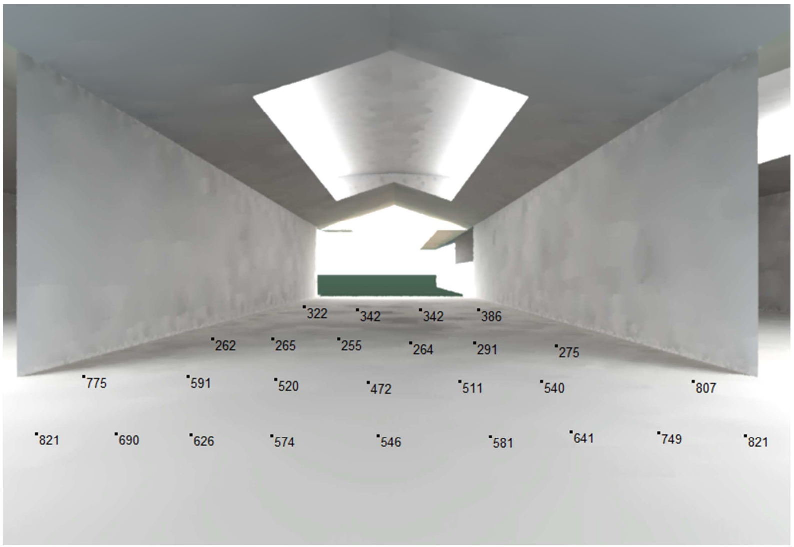


Figure 61 - October 15th 2011 Bridge North Bay 12:00 PM Illumination Levels (Lux)

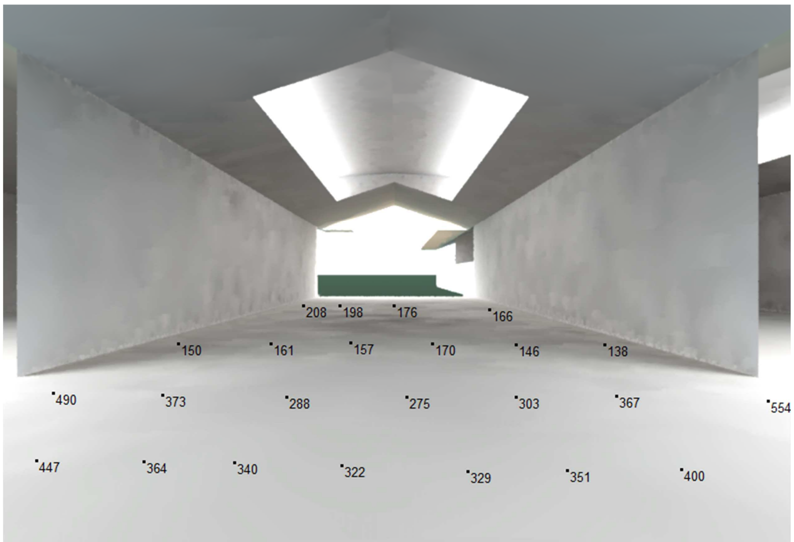


Figure 62 - October 15th 2011 Bridge North Bay 4:00 PM Illumination Levels (Lux)

Conclusion – Sufficient illumination levels available at all times

November 15, 2011

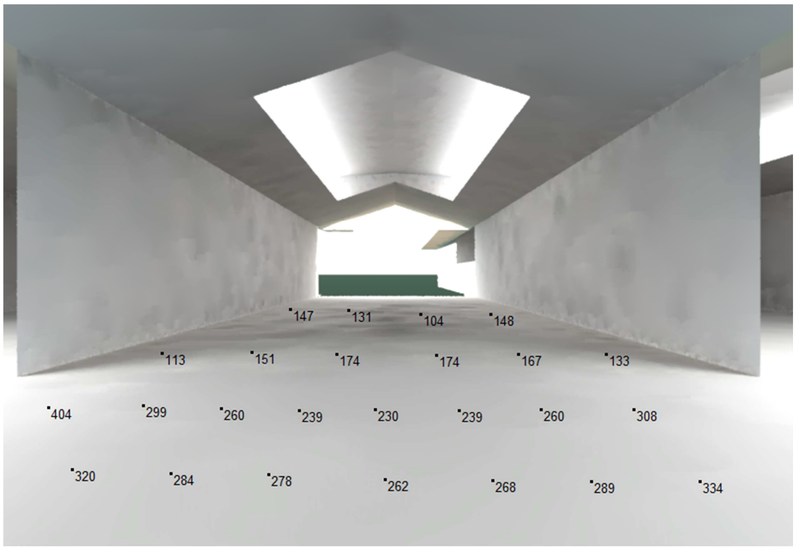


Figure 63 - November 15th 2011 Bridge North Bay 9:00 AM Illumination Levels (Lux)

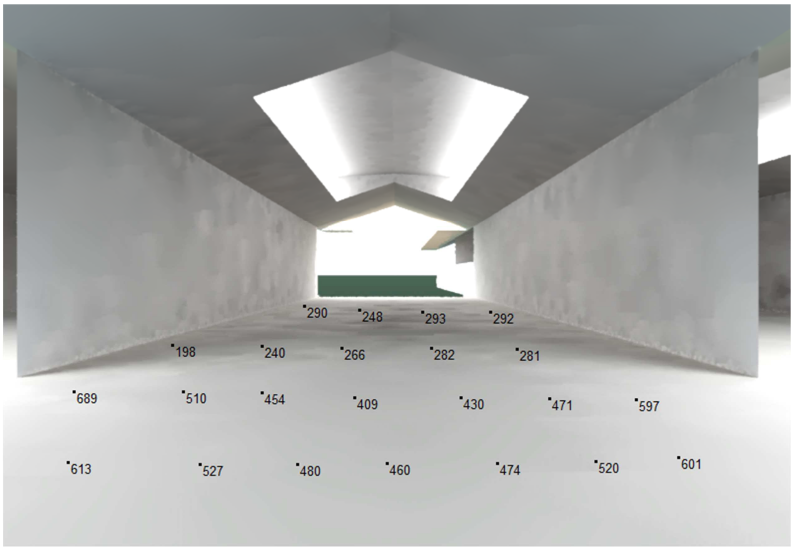


Figure 64 - November 15th 2011 Bridge North Bay 12:00 PM Illumination Levels (Lux)

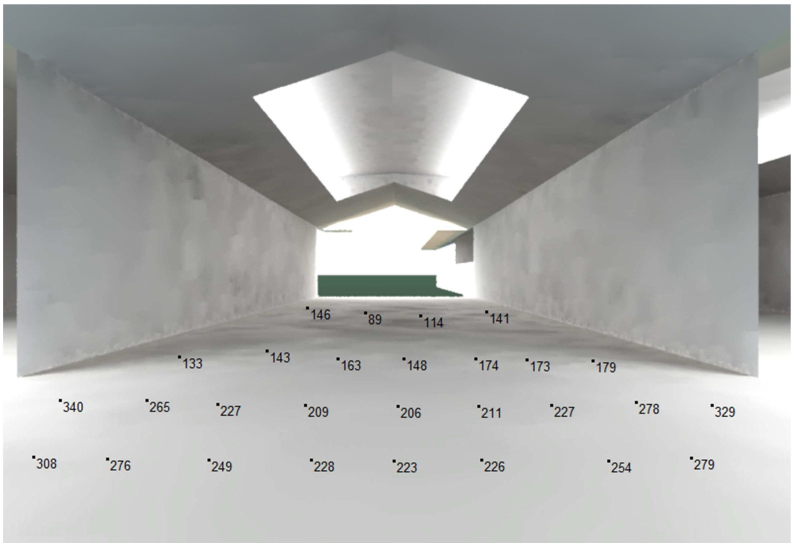


Figure 65 - November 15th 2011 Bridge North Bay 4:00 PM Illumination Levels (Lux)

Conclusion – Sufficient illumination levels available at all times

December, 2011

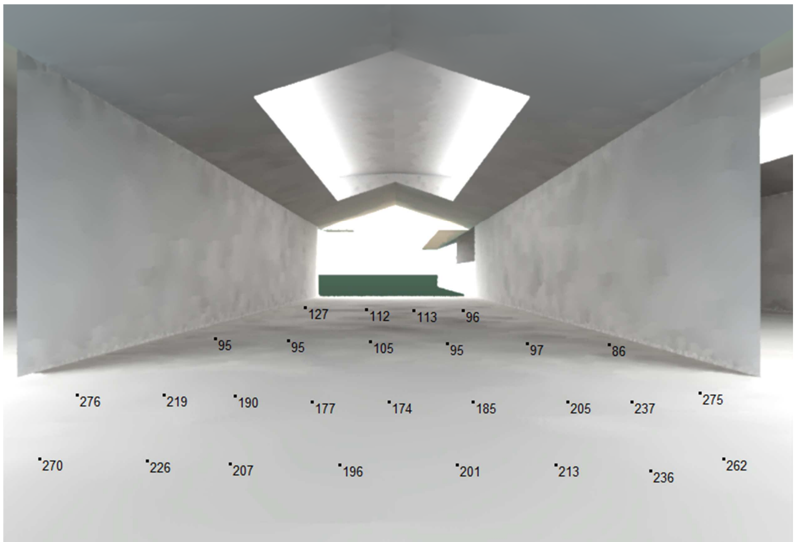


Figure 66 - December 15th 2011 Bridge North Bay 9:00 AM Illumination Levels (Lux)

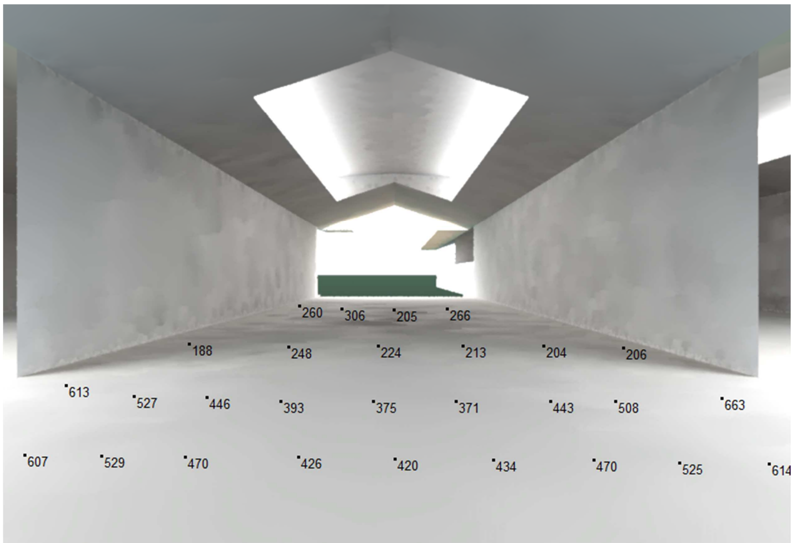


Figure 67 - December 15th 2011 Bridge North Bay 12:00 PM Illumination Levels (Lux)

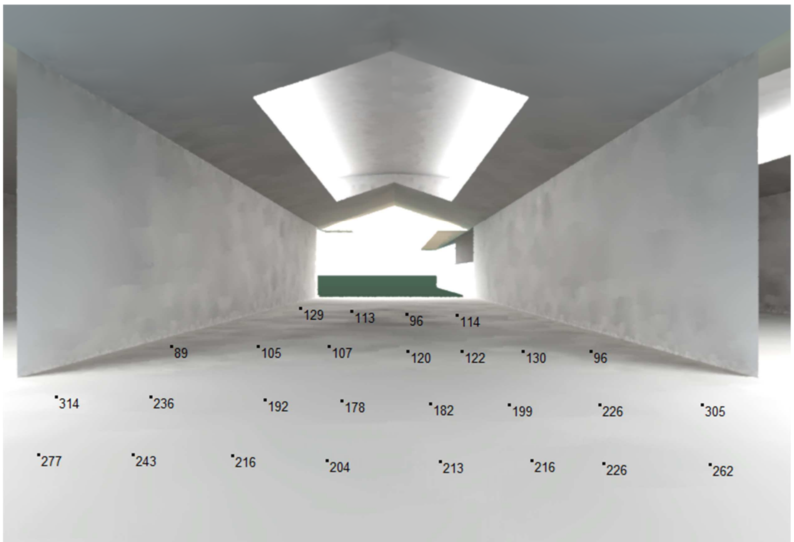


Figure 68 - December 15th 2011 Bridge North Bay 4:00 PM Illumination Levels (Lux)

Conclusion – Sufficient illumination levels available at all times

APPENDIX F

RESULTS FROM SIMULATING BUILDING AS-OPERATED

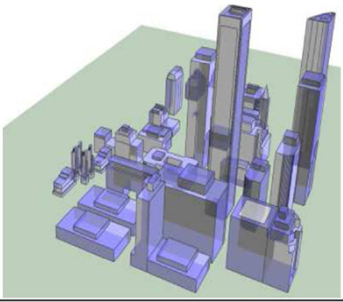
Results of Simulating the Building Modeled in IES-VE to be as close as possible to actually Built and Operated

GEHC Final.mit
01/Jul/2011

Contents: **Project Summary** Model Calc. data Weather 2030 **System** Energy Carbon **Comfort** Occupied Full day **Loads** Peak hourly room

Project summary

Building



History

#	Total	Heating	Cooling	Fans/Pumps	Lights	Equip.
run1	9108	1396	2553	599	1741	1106

Model data:

Project file	GEHC Final.mit
Building floor area	56929.34 ft^2
Total volume	1017560.94 ft^3

Calculation data:

Results file"c:\..\gehc final 6 currentop.aps"

Calculated	01/Jul/2011 on 05:38
Calc. Period:	01/Jan - 31/Dec

Weather:

Climate file	AtlantaTMY2.fwt

Architecture 2030 Challenge:

Current design -142 % Reduction

Meets Does not meet current targettarget

Public assembly

Design Building Energy Use Intensity: 160kBTU/ft^2
(Design EUI = Energy / Building Area)

Average Building Energy Use Intensity: 66kBTU/ft^2
(Used to generate 2030 Challenge Targets)

Note: The results in this report are generated by the IES ApacheSim module. ApacheSim is a rigorous building thermal simulation approach that conforms to ANSI/ASHRAE Standard 140. If you wish to know more about ApacheSim and obtain a copy of the ANSI/ASHRAE 140 standard report select the following link (will open new window) www.iesve.com/apachesim

The Architecture 2030 Challenge provides a roadmap of targets for US building projects culminating in being carbon neutral by 2030

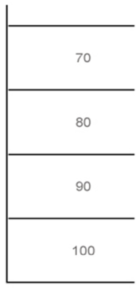
Implementation of the Challenge requires the use of targets by building type derived from current building stock benchmarks; many from the EPC?s Target Finder

Challenge targets for selected building type:

% reduction
50
60

Figure 69 - GEHC Current Operations IES-VE Output, Page 1

Page 2 of 6



For certain building types targets are calculated using Energy Star methodology where energy consumption is not a direct % reduction against average

Building systems energy

Summary

Month	Heating (boilers etc.)	Cooling (chillers etc.)	Fans, pumps and controls	Lights	Equip.
A-Z	Hi/Lo	Hi/Lo	Hi/Lo	Hi/Lo	Hi/Lo
Jan	285.0	4.5	24.2	143.1	93.0
Feb	228.6	14.3	27.6	133.6	84.8
Mar	152.6	34.8	37.7	152.9	94.5
Apr	88.7	106.5	50.5	142.7	91.3
May	36.6	239.6	66.2	145.0	93.0
Jun	25.5	405.2	67.3	146.4	91.3
Jul	25.6	557.0	69.9	145.2	93.8
Aug	25.7	552.9	70.3	148.9	93.8
Sep	27.9	448.7	68.1	144.6	91.3
Oct	77.4	146.1	54.6	143.1	93.0
Nov	166.3	30.5	34.5	146.4	91.3
Dec	255.7	13.2	28.0	149.1	94.5
Total	1,395.7	2,553.4	598.8	1,741.1	1,105.7

MBtu

The maximum value in each column is highlighted in red. The minimum value in each column is highlighted in blue.
More than one value may be highlighted

Total Yearly Energy Consumption = 9,107.8MBtu

Total Yearly Energy Consumption per Floor Area = 160.0kBTU/ft^2

Figure 70- GEHC Current Operations IES-VE Output, Page 2

Carbon Dioxide

Summary	Month	System (boilers, chillers, fans,pumps)	Lights	Equip.	lbCO2
	A-Z	Hi/Lo	Hi/Lo	Hi/Lo	The maximum value in each column is highlighted in red. The minimum value in each column is highlighted in blue. More than one value may be highlighted
	Jan	143,061.8	62,551.1	40,654.8	
	Feb	137,572.6	58,377.6	37,063.4	
	Mar	133,332.0	66,802.6	41,319.3	
	Apr	171,636.8	62,369.8	39,900.6	
	May	249,535.7	63,363.3	40,654.8	**Total carbon dioxide emissions = 3,980,397.8lbCO2**
	Jun	319,617.4	63,994.3	39,900.7	
	Jul	393,290.3	63,458.5	40,987.0	
	Aug	387,409.8	65,083.0	40,987.0	
	Sep	335,078.4	63,182.0	39,900.7	
	Oct	190,073.2	62,551.1	40,654.8	
	Nov	130,930.1	63,994.3	39,900.7	
	Dec	144,711.0	65,178.1	41,319.3	
	Total	2,736,249.3	760,905.6	483,243.0	

Figure 71 - GEHC Current Operations IES-VE Output, Page 3

Comfort - Occupied

Occupied

Room Name	Temp Max °F	Temp Min °F	Relative Humidity Max %	Relative Humidity Min %	PPD Max %	PPD Min %
A-Z	Hi/Lo	Hi/Lo	Hi/Lo	Hi/Lo	Hi/Lo	Hi/Lo
Apply					15	
Mech/Elec 2	76.2	64.1	83.8	6.4	23.7	5.0
Restrooms 1	-	-	-	-	-	-
Corridor 2	-	-	-	-	-	-
Machine/Elevator 1	79.0	60.8	77.4	7.1	38.2	5.0
Open Office 2	97.8	54.5	97.5	10.7	100.0	5.0
Open Office 3	82.3	59.2	75.6	8.8	58.1	5.0
Workshop 1	81.9	65.9	85.3	20.2	54.9	5.0
Mech/Elec/Elev 4	81.2	64.7	74.7	8.4	50.2	5.0
Office 1	84.2	59.0	75.1	8.8	66.9	5.0
Classroom 3	92.8	61.6	95.2	18.9	97.3	5.0
Corridor 1	-	-	-	-	-	-
Mech 1	84.1	60.4	71.0	7.3	62.3	5.0
Mech/Elec 3	88.5	62.0	70.6	6.8	84.7	5.0
Storage 1	-	-	-	-	-	-
Classroom 1	92.9	62.2	92.6	19.0	97.3	5.0
Classroom 2	92.7	61.9	96.6	19.9	97.3	5.0
Storage 2	-	-	-	-	-	-
New Open Office 1	87.4	55.5	76.5	10.1	83.3	5.0
Mech/Elec 1	81.6	65.1	73.1	6.0	54.8	5.0
Bridge 1	110.8	47.2	100.0	19.6	100.0	5.0
Office 2	103.5	41.9	84.3	13.9	100.0	5.0
Dining 1	100.2	50.0	89.3	8.8	100.0	5.0
Blue Planet 1	100.4	37.0	100.0	15.1	100.0	5.0
Customer Area 1	100.1	45.2	97.2	18.5	100.0	5.0
Classroom 4	110.4	53.5	100.0	26.0	100.0	5.0
Classroom 5	106.5	51.9	100.0	23.8	100.0	5.0
Changing Displays 2	92.4	43.5	84.2	10.0	100.0	5.0
Changing Displays 1	94.1	44.8	84.1	10.1	98.6	5.0
Discover H2O	100.8	45.1	100.0	29.3	100.0	5.0

PPD is the percentage of people that will find the room thermally uncomfortable

Please alter the PPD max limit value to highlight rooms that are more thermally uncomfortable

(US Only)ASHRAE 55 states comfort lies between 5 and 10% PPD

Figure 72 - GEHC Current Operations IES-VE Output, Page 4

Comfort - Full Day

Full Day

om Name	Temp Max °F	Temp Min °F	Relative Humidity Max %	Relative Humidity Min %	PPD Max %	PPD Min %
A-Z	Hi/Lo	Hi/Lo	Hi/Lo	Hi/Lo	Hi/Lo	Hi/Lo
Apply					50	
Mech/Elec 2	76.2	63.8	83.8	4.5	24.6	5.0
Restrooms 1	77.9	64.8	81.7	4.1	34.5	5.0
Corridor 2	86.1	56.7	79.2	5.4	73.6	5.0
Machine/Elevator 1	79.0	59.8	77.4	5.1	44.8	5.0
Open Office 2	97.8	52.7	97.5	6.5	100.0	5.0
Open Office 3	82.3	56.4	77.5	5.2	64.6	5.0
Workshop 1	81.9	62.2	85.3	4.7	54.9	5.0
Mech/Elec/Elev 4	81.2	63.9	74.7	4.4	50.2	5.0
Office 1	84.2	57.6	75.1	4.8	66.9	5.0
Classroom 3	92.8	57.5	95.2	4.4	97.3	5.0
Corridor 1	79.9	56.0	81.6	5.9	60.9	5.0
Mech 1	84.1	59.9	71.1	5.2	62.3	5.0
Mech/Elec 3	88.6	61.4	70.6	5.1	84.7	5.0
Storage 1	80.8	54.4	84.1	6.1	71.0	5.0
Classroom 1	92.9	58.1	92.6	4.4	97.3	5.0
Classroom 2	92.7	57.3	96.6	4.6	97.3	5.0
Storage 2	78.1	56.8	86.1	5.6	58.8	5.0
New Open Office 1	87.4	54.1	77.2	5.5	83.3	5.0
Mech/Elec 1	81.6	64.8	73.1	4.2	54.8	5.0
Bridge 1	110.8	47.2	100.0	19.6	100.0	5.0
Office 2	103.5	39.5	85.4	9.9	100.0	5.0
Dining 1	100.2	50.0	89.3	8.8	100.0	5.0
Blue Planet 1	100.4	37.0	100.0	15.1	100.0	5.0
Customer Area 1	100.1	43.5	97.2	10.1	100.0	5.0
Classroom 4	110.4	49.3	100.0	7.2	100.0	5.0
Classroom 5	106.5	46.1	100.0	7.6	100.0	5.0
Changing Displays 2	92.4	43.5	84.2	9.3	100.0	5.0
Changing Displays 1	94.1	44.8	84.1	9.7	98.6	5.0
Discover H2O	100.8	43.6	100.0	10.6	100.0	5.0

PPD is the percentage of people that will find the room thermally uncomfortable

Please alter the PPD max limit value to highlight rooms that are more thermally uncomfortable

(US Only)ASHRAE 55 states comfort lies between 5 and 10% PPD

Figure 73 - GEHC Current Operations IES-VE Output, Page 5

Peak Hourly Room Loads

Peak Loads

	Peak Room Conditioning Loads (Btu/h)				Internal Gains	*Cooling Checks	
Room Name	Sensible Heating	Sensible Cooling	Humidification	Dehumidification	(Btu/h)	(Btu/h•ft^2)	(cfm/ft^2)
A-Z	Hi/Lo	Hi/Lo	Hi/Lo	Hi/Lo	Hi/Lo	Hi/Lo	Hi/Lo
Apply						30	
Mech/Elec 2	4735	7413	1280	2379	3227	15.67	1.01
Restrooms 1	4489	8691	1286	2169	1242	18.26	1.18
Corridor 2	6374	16395	2608	5270	9022	8.49	0.55
Machine/Elevator 1	5664	11121	1582	3015	4394	17.27	1.11
Open Office 2	7292	25575	3224	15005	74005	4.78	0.31
Open Office 3	6435	12589	1321	2982	6823	25.54	1.64
Workshop 1	5091	13452	1424	7005	8622	24.49	1.58
Mech/Elec/ Elev 4	4698	13123	1852	4506	5904	15.57	1.00
Office 1	6159	13437	1544	3586	8581	21.67	1.39
Classroom 3	6201	19840	2020	11279	23401	19.45	1.25
Corridor 1	6533	11566	2342	4533	6688	8.08	0.52
Mech 1	5631	16221	2664	5891	12438	8.90	0.57
Mech/Elec 3	5279	19609	4935	7568	20565	6.51	0.42
Storage 1	6903	12041	2256	4278	7928	9.33	0.60
Classroom 1	6041	20184	2111	12206	25742	17.99	1.16
Classroom 2	6244	20323	2089	11934	25053	18.61	1.20
Storage 2	6361	9478	1947	3501	5681	10.25	0.66
New Open Office 1	6972	15376	1696	4027	9965	21.36	1.37
Mech/Elec 1	4494	12533	1360	2534	3515	24.33	1.57
Bridge 1	8565	32964	4502	28587	119017	4.57	0.29
Office 2	10366	27406	2899	9524	34037	11.14	0.72
Dining 1	7934	25922	3128	14883	45544	7.45	0.48
Blue Planet 1	10930	26196	2410	13807	51483	6.21	0.40
Customer Area 1	9438	24806	2986	13122	31143	7.90	0.51
Classroom 4	8095	32893	6993	33556	92304	8.18	0.53
Classroom 5	8837	29645	2850	22588	53302	12.76	0.82
Changing Displays 2	9431	19578	2031	7711	20067	11.91	0.77
Changing Displays 1	9144	20915	2267	9634	28371	9.00	0.58
Discover H2O	9406	25292	2013	25637	25832	14.21	0.91

Recommended strategies to reduce the loads on these rooms are:
- reorient the building
- move rooms with high internal gain to avoid solar penetration
- increase u-values of constructions
- improve solar performance of the glazing

Figure 74 - GEHC Current Operations IES-VE Output, Page 6

Total lights energy (MWh)
gehc final 6 currentop.aps

Date	
Jan 01-31	41.9466
Feb 01-28	39.1479
Mar 01-31	44.7977
Apr 01-30	41.8250
May 01-31	42.4913
Jun 01-30	42.9144
Jul 01-31	42.5551
Aug 01-31	43.6445
Sep 01-30	42.3697
Oct 01-31	41.9466
Nov 01-30	42.9144
Dec 01-31	43.7083
Summed total	510.2615

Figure 75 - GEHC Current Operations IES-VE Output, Page 7

APPENDIX G

RESULTS FROM SIMULATING RECOMMENDATIONS

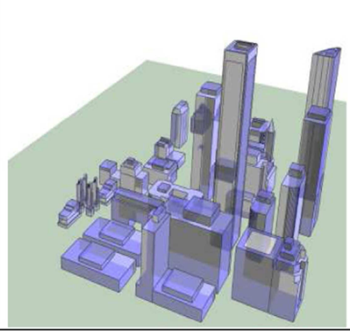
Results of Simulating the Building Modeled in IES-VE with the Recommended Optimizations

GEHC Final.mit
01/Jul/2011

Contents: **Project Summary** Model Calc. data Weather 2030 **System** Energy Carbon **Comfort** Occupied Full day **Loads** Peak hourly room

Project summary

Building



History

#	Total	Heating	Cooling	Fans/Pumps	Lights	Equip.
run1	8205	1498	2455	592	845	1106

Model data:

Project file GEHC Final.mit

Building floor area 56929.34 ft^2

Total volume 1017560.94 ft^3

Calculation data:

Results file "c:\..\gehc final 7 reco.aps"

Calculated 01/Jul/2011 on 06:02

Calc. Period: 01/Jan - 31/Dec

Weather:

Climate file AtlantaTMY2.fwt

Architecture 2030 Challenge:

Current design -118 % Reduction

Meets Does not meet current targettarget

Public assembly

Design Building Energy Use Intensity: 144kBTU/ft^2
(Design EUI = Energy / Building Area)

Average Building Energy Use Intensity: 66kBTU/ft^2
(Used to generate 2030 Challenge Targets)

Note: The results in this report are generated by the IES ApacheSim module. ApacheSim is a rigorous building thermal simulation approach that conforms to ANSI/ASHRAE Standard 140. If you wish to know more about ApacheSim and obtain a copy of the ANSI/ASHRAE 140 standard report select the following link (will open new window) www.iesve.com/apachesim

The Architecture 2030 Challenge provides a roadmap of targets for US building projects culminating in being carbon neutral by 2030

Implementation of the Challenge requires the use of targets by building type derived from current building stock benchmarks; many from the EPC?s Target Finder

Challenge targets for selected building type:

% reduction
50
60

Figure 76 - GEHC Recommended Operations IES-VE Output, Page 1

70
80
90
100

For certain building types targets are calculated using Energy Star methodology where energy consumption is not a direct % reduction against average

Building systems energy

Summary

Month	Heating (boilers etc.)	Cooling (chillers etc.)	Fans, pumps and controls	Lights	Equip.
A-Z	Hi/Lo	Hi/Lo	Hi/Lo	Hi/Lo	Hi/Lo
Jan	292.3	4.3	23.5	72.7	93.0
Feb	237.0	13.2	26.9	64.8	84.8
Mar	172.0	32.4	36.3	70.2	94.5
Apr	101.7	99.3	49.1	70.7	91.3
May	44.5	228.8	65.8	71.6	93.0
Jun	26.7	390.1	67.6	68.4	91.3
Jul	26.2	545.4	70.8	73.2	93.8
Aug	26.4	538.2	71.0	70.9	93.8
Sep	31.1	426.3	67.9	69.5	91.3
Oct	90.6	136.7	53.0	72.7	93.0
Nov	183.3	28.0	33.3	68.4	91.3
Dec	265.7	12.3	27.1	72.5	94.5
Total	1,497.6	2,455.0	592.4	845.5	1,105.7

MBtu

The maximum value in each column is highlighted in red. The minimum value in each column is highlighted in blue.
More than one value may be highlighted

Total Yearly Energy Consumption = 8,205.5MBtu

Total Yearly Energy Consumption per Floor Area = 144.1kBTU/ft^2

Figure 77 - GEHC Recommended Operations IES-VE Output, Page 2

Carbon Dioxide

Summary

Month	System (boilers, chillers, fans,pumps)	Lights	Equip.
A-Z	Hi/Lo	Hi/Lo	Hi/Lo
Jan	145,813.0	31,787.3	40,654.8
Feb	140,458.7	28,324.6	37,063.4
Mar	140,142.5	30,657.7	41,319.3
Apr	173,383.2	30,895.3	39,900.6
May	247,806.6	31,279.7	40,654.8
Jun	313,354.8	29,880.0	39,900.7
Jul	388,681.2	31,984.0	40,987.0
Aug	381,432.9	30,968.7	40,987.0
Sep	326,231.9	30,387.7	39,900.7
Oct	190,969.7	31,787.3	40,654.8
Nov	136,711.6	29,880.0	39,900.7
Dec	148,314.9	31,673.0	41,319.3
Total	2,733,300.8	369,505.2	483,243.0

lbCO2

The maximum value in each column is highlighted in red. The minimum value in each column is highlighted in blue.
More than one value may be highlighted

Total carbon dioxide emissions = 3,586,049.0lbCO2

Figure 78 - GEHC Recommended Operations IES-VE Output, Page 3

Comfort - Occupied

	Room Name	Temp Max °F	Temp Min °F	Relative Humidity Max %	Relative Humidity Min %	PPD Max %	PPD Min %
	A-Z	Hi/Lo	Hi/Lo	Hi/Lo	Hi/Lo	Hi/Lo	Hi/Lo
	Apply					15	
Occupied	Mech/Elec 2	75.9	63.5	84.6	6.5	26.2	5.0
	Restrooms 1	-	-	-	-	-	-
	Corridor 2	-	-	-	-	-	-
	Machine/Elevator 1	78.9	60.1	77.6	7.3	42.4	5.0
	Open Office 2	94.5	56.1	100.0	12.5	97.4	5.0
	Open Office 3	80.8	60.2	75.9	9.3	48.0	5.0
	Workshop 1	81.6	65.0	85.6	20.5	52.7	5.0
	Mech/Elec/Elev 4	80.1	63.2	77.9	9.0	42.6	5.0
	Office 1	82.9	60.0	75.8	9.6	58.7	5.0
	Classroom 3	90.2	63.1	93.5	23.2	92.5	5.0
	Corridor 1	-	-	-	-	-	-
	Mech 1	83.7	59.2	72.3	7.6	58.7	5.0
	Mech/Elec 3	87.5	60.0	72.0	7.4	78.3	5.0
	Storage 1	-	-	-	-	-	-
	Classroom 1	90.2	64.1	92.6	23.4	92.1	5.0
	Classroom 2	90.1	63.3	95.0	23.4	92.0	5.0
	Storage 2	-	-	-	-	-	-
	New Open Office 1	86.3	56.8	74.7	10.9	77.9	5.0
	Mech/Elec 1	80.1	63.8	76.3	6.5	44.8	5.0
	Bridge 1	107.6	44.8	100.0	24.9	100.0	5.0
	Office 2	101.7	42.7	84.1	14.6	100.0	5.0
	Dining 1	98.1	46.9	95.0	10.5	100.0	5.0
	Blue Planet 1	98.3	35.4	100.0	19.4	100.0	5.0
	Customer Area 1	98.8	44.6	99.9	19.0	100.0	5.0
	Classroom 4	106.5	53.7	100.0	31.7	100.0	5.0
	Classroom 5	104.0	51.4	100.0	25.8	100.0	5.0
	Changing Displays 2	91.7	41.9	85.9	11.6	100.0	5.0
	Changing Displays 1	93.1	43.0	87.2	11.9	100.0	5.0
	Discover H2O	100.1	43.0	100.0	31.9	100.0	5.0

PPD is the percentage of people that will find the room thermally uncomfortable

Please alter the PPD max limit value to highlight rooms that are more thermally uncomfortable

(US Only)ASHRAE 55 states comfort lies between 5 and 10% PPD

Figure 79 - GEHC Recommended Operations IES-VE Output, Page 4

Comfort - Full Day

Full Day

om Name	Temp Max °F	Temp Min °F	Relative Humidity Max %	Relative Humidity Min %	PPD Max %	PPD Min %
A-Z	Hi/Lo	Hi/Lo	Hi/Lo	Hi/Lo	Hi/Lo	Hi/Lo
Apply					50	
Mech/Elec 2	75.9	63.1	84.6	4.5	28.0	5.0
Restrooms 1	76.6	63.5	84.6	4.5	27.1	5.0
Corridor 2	83.8	55.3	81.1	6.1	63.7	5.0
Machine/Elevator 1	78.9	59.0	78.1	5.2	49.4	5.0
Open Office 2	94.5	51.0	100.0	8.1	97.4	5.0
Open Office 3	80.8	55.6	78.3	5.8	69.3	5.0
Workshop 1	81.6	61.3	85.6	4.8	52.7	5.0
Mech/Elec/Elev 4	80.1	62.2	77.9	4.7	42.6	5.0
Office 1	82.9	56.7	75.8	5.6	61.4	5.0
Classroom 3	90.2	55.7	93.5	5.8	92.5	5.0
Corridor 1	79.3	55.1	82.0	6.1	66.5	5.0
Mech 1	83.7	58.6	72.6	5.4	58.7	5.0
Mech/Elec 3	87.5	59.4	72.0	5.5	78.3	5.0
Storage 1	80.3	53.3	85.5	6.3	76.8	5.0
Classroom 1	90.2	56.5	92.6	5.7	92.1	5.0
Classroom 2	90.1	55.4	95.0	5.9	92.0	5.0
Storage 2	77.8	56.0	86.1	5.8	63.4	5.0
New Open Office 1	86.3	53.4	78.8	6.3	78.7	5.0
Mech/Elec 1	80.3	63.3	76.3	4.5	45.6	5.0
Bridge 1	107.6	44.8	100.0	24.9	100.0	5.0
Office 2	101.7	37.5	87.0	11.7	100.0	5.0
Dining 1	98.1	46.9	95.0	10.5	100.0	5.0
Blue Planet 1	98.3	35.4	100.0	19.4	100.0	5.0
Customer Area 1	98.8	42.0	99.9	10.7	100.0	5.0
Classroom 4	106.5	46.4	100.0	10.2	100.0	5.0
Classroom 5	104.0	43.1	100.0	9.8	100.0	5.0
Changing Displays 2	91.7	41.9	85.9	10.8	100.0	5.0
Changing Displays 1	93.1	43.0	87.2	11.5	100.0	5.0
Discover H2O	100.1	41.4	100.0	12.7	100.0	5.0

PPD is the percentage of people that will find the room thermally uncomfortable

Please alter the PPD max limit value to highlight rooms that are more thermally uncomfortable

(US Only)ASHRAE 55 states comfort lies between 5 and 10% PPD

Figure 80 - GEHC Recommended Operations IES-VE Output, Page 5

Peak Hourly Room Loads

Peak Loads

Room Name	Sensible Heating	Sensible Cooling	Humidification	Dehumidification	Internal Gains (Btu/h)	*Cooling Checks (Btu/h•ft^2)	*Cooling Checks (cfm/ft^2)
	Peak Room Conditioning Loads (Btu/h)						
A-Z	Hi/Lo	Hi/Lo	Hi/Lo	Hi/Lo	Hi/Lo	Hi/Lo	Hi/Lo
Apply						30	
Mech/Elec 2	4896	7378	1280	2379	3227	15.60	1.00
Restrooms 1	4795	7536	1287	2170	1242	15.83	1.02
Corridor 2	6691	15073	2572	5272	9022	7.80	0.50
Machine/Elevator 1	5837	11097	1582	3015	4394	17.23	1.11
Open Office 2	7689	23513	3150	15070	74005	4.40	0.28
Open Office 3	6627	11600	1321	2986	6823	23.53	1.51
Workshop 1	5304	13393	1424	7005	8622	24.38	1.57
Mech/Elec/Elev 4	5094	12851	1851	4507	5904	15.25	0.98
Office 1	6382	12418	1544	3591	8581	20.03	1.29
Classroom 3	6606	18262	2038	11290	23401	17.90	1.15
Corridor 1	6752	11401	2341	4533	6688	7.96	0.51
Mech 1	5923	16098	2543	5892	12438	8.83	0.57
Mech/Elec 3	5749	19200	3938	7570	20565	6.37	0.41
Storage 1	7156	11765	2256	4278	7928	9.11	0.59
Classroom 1	6422	18521	2132	12218	25742	16.51	1.06
Classroom 2	6666	18814	2107	11945	25053	17.23	1.11
Storage 2	6541	9222	1947	3501	5681	9.97	0.64
New Open Office 1	7137	14677	1696	4032	9965	20.38	1.31
Mech/Elec 1	4846	12174	1361	2535	3515	23.63	1.52
Bridge 1	9127	30525	3367	28649	119017	4.23	0.27
Office 2	10818	25835	2902	9531	34037	10.50	0.68
Dining 1	8656	24287	2431	15271	45544	6.98	0.45
Blue Planet 1	11316	25137	2266	13943	51483	5.96	0.38
Customer Area 1	9785	23857	2964	13164	31143	7.60	0.49
Classroom 4	8757	30017	4833	32395	92304	7.46	0.48
Classroom 5	9533	27861	2767	23065	53302	11.99	0.77
Changing Displays 2	9800	19295	1982	7741	20067	11.74	0.76
Changing Displays 1	9540	20413	2216	9681	28371	8.79	0.57
Discover H2O	9929	24861	1926	24936	25832	13.97	0.90

Recommended strategies to reduce the loads on these rooms are:
- reorient the building
- move rooms with high internal gain to avoid solar penetration
- increase u-values of constructions
- improve solar performance of the glazing

Figure 19 - GEHC Recommended Operations IES-VE Output, Page 6

Total lights energy (MWh)
gehc final 7 reco.aps

Date	
Jan 01-31	21.3165
Feb 01-28	18.9944
Mar 01-31	20.5590
Apr 01-30	20.7183
May 01-31	20.9761
Jun 01-30	20.0374
Jul 01-31	21.4484
Aug 01-31	20.7675
Sep 01-30	20.3779
Oct 01-31	21.3165
Nov 01-30	20.0374
Dec 01-31	21.2398
Summed total	247.7892

Figure 82 - GEHC Recommended Operations IES-VE Output, Page 7

Contribution of the Envelope to Heating and Cooling Load

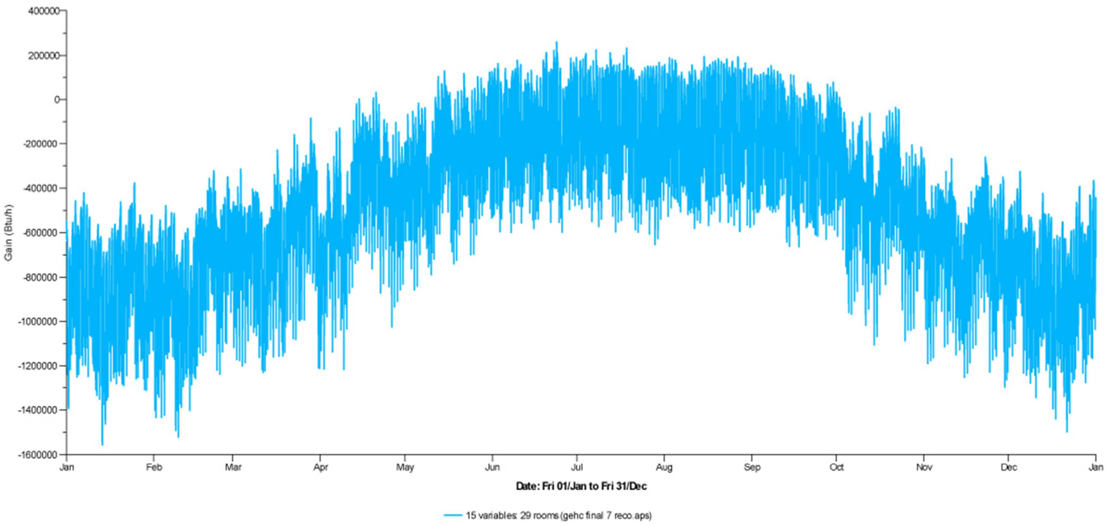


Figure 83 - Heating and Cooling Load from Envelope

Date	15 variables (kBtu) 29 rooms gehc final 7 reco.aps
Jan 01-31	-603447
Feb 01-28	-514903
Mar 01-31	-448666
Apr 01-30	-300782
May 01-31	-153250
Jun 01-30	-54070
Jul 01-31	-46085
Aug 01-31	-48949
Sep 01-30	-97537
Oct 01-31	-287457
Nov 01-30	-455321
Dec 01-31	-575516
Summed total	-3585982

Figure 20 - Total Load Contributed by Envelope

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